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Towards an applied archaeology of east African intensive agricultural systems

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Abstract

This study questions whether archaeological techniques and perspectives can be applied to aid in the assessment of rural development practices in Africa, and is a response to a gradual paradigm shift that rejects large-scale, top-down modernisation programmes in favour of small-scale projects that are managed locally and employ 'indigenous' systems of knowledge. In Africa, as in other parts of the developing world, the projects that have adopted this alternative approach have tended to focus on rural economies and have drawn upon recent research that has emphasised the unique contexts of individual communities' approaches to resource exploitation, and which have demonstrated the ability of many societies to maintain modes of economy that various western derived models would expect to be unsustainable. Although these studies have originated from a variety of disciplinary standpoints and have, in general, stressed the need for a multidisciplinary approach, archaeological data is rarely employed. Superficially, however, the case for an archaeological contribution seems self-evident, since any appraisal of sustainability clearly requires an assessment of how long a particular agronomy has been in operation, and whether or not the practices that have sustained it have changed through time.

The current study explores the implications of increased archaeological involvement in this area of research by questioning whether an 'applied archaeology' of African agriculture would be theoretically desirable and pragmatically feasible. The question of desirability includes a discussion of the inevitable political implications of contributing to contemporary developmental debates, but focuses primarily on the more overtly theoretical issue of inter-epistemological translation: arguing for a return to the level of relativism espoused by early post-processualism, and adopting a shift in emphasis that incorporates the construction of plausible pasts alongside a functional approach that may offer insights of value to contemporary communities.

In order to assess the feasibility of an archaeological contribution, this paper presents the findings of recent fieldwork at the late precolonial site of Engaruka, in north-eastern Tanzania. These results show that the system of terraces and irrigation features formerly employed at the site were completely integrated to produce a unique and sophisticated response to the problems of farming in this area, and demonstrate that relatively simple, and readily taught, archaeological techniques have the potential to model precisely the development and expansion of agricultural systems, and can do so over a longer period than the methods available to other disciplines. The thesis concludes, therefore, that there is a real need for a truly interdisciplinary approach to this area of study, and that such an approach should include an archaeological component.

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The fieldwork was carried out by Graduate Attachments to the BIEA with the assistance of BIEA staff and representatives of the Tanzanian Department of Antiquities. Excavation is a process that can only be effectively and efficiently undertaken as a team, and is also one in which it is impossible to completely separate observation from interpretation. Team members were therefore not only responsible for the excavation, recording and interpretation of their own features or areas, but were also the people who understood these areas best. Their individual and collective contribution to the fieldwork, and to discussions regarding the broader significance of these findings, is gratefully acknowledged. The degree to which the skills and interpretative insights of the fieldwork team both benefit and shape an excavation project is all too often overlooked and, as such, the interpretations and opinions of members of the team are referenced in the text by surname.

In 2002 the team comprised Kennedy Gitu, Jane Humphris, Helen Lidington, Charlotte North, Stephen Manoa Oina and Edward Pollard of the BIEA, with the assistance of Ferdinand Mzambwa of The United Republic of Tanzania Ministry of Natural Resources and Tourism Antiquities Unit, who also monitored the work. Additional assistance was provided by the site's Tanzanian Department of Antiquities appointed guardian, Israel O. Molel. The excavation in 2003 was undertaken by Nick Black, Will Ellerby, Emmanuel James and Daniel Rhodes of the BIEA, and by the local representatives of the Department of Antiquities: Israel O. Molel and Vincent Saningo. Monitoring of the excavation was undertaken by Ndeuli Mohammed of the Antiquities Unit, who also assisted with the EDM survey undertaken by Stephen Manoa Oina. Additional support with vehicles and driving was provided by Joseph Mutua. Thanks are due for their hard work, expertise, good humour, enthusiasm and patience.

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To Ari and Jim

Both of whom saw the start of this project but not the end.

Both, however, would have no doubt wryly suggested that you read something else.

1

Introduction

> Pure contemplation is no more creative activity than is the cyclical movement of a wheel. Knowledge is not to be contemplated but to guide action. That is not to say that the pursuit of knowledge for its own sake, pure science, is futile or meaningless. Major scientific discoveries of the greatest practical utility were indubitably made for precisely that motive without any reference to possible use. Yet the practical results, however long delayed, provide the sole conclusive test of the truth of the discovery, the proof that it is a contribution to knowledge and not just a new superstition [...] I am an archaeologist and devote my time to trying to gather information about the behaviour of men long since dead. I like doing this and my society pays me quite well for doing it. Yet neither I nor society can see any immediate practical applications for the information I gather; we are indeed quite sure that it will not increase the production of bombs or butter. Still, we like to think that even archaeological knowledge may someday prove useful to some society.
>
> (Childe 1956: 127)

The object of study of this thesis could be defined very broadly as concerning archaeology: its aims; its role; its function and, in line with the ambition expressed in the above quotation, its potential application. One such application, the use of archaeological techniques to aid in the study of indigenous systems of land management, is explored here through the general case study of east African intensive agriculture, which is itself then investigated in greater detail by outlining the results of recent fieldwork on the abandoned precolonial[1] agricultural site at Engaruka, Tanzania. In short, the project aims to offer an archaeological contribution to developmental narratives that regard indigenous systems of resource exploitation as potential paradigms for sustainable and locally managed rural development, but which tend to do so without fully understanding the long term histories of the communities and management strategies they cite. The thesis will therefore explore how such a contribution might be made, and will include an assessment of the strengths and weaknesses of archaeological data in this regard.

In terms of the general case study, the project takes as its starting point the recognition that the past, or perceptions of the past, play a significant role in debates concerning the sustainable management of resources in the developing world and, as such, questions whether an archaeological contribution to these debates would be theoretically desirable and

[1] The terms 'precolonial' and 'postcolonial' have been criticised for placing undue emphasis on the colonial period as a point of historical reference. However, these terms are used here since 'prehistoric' implies that the oral traditions of non-literate communities are not valid histories, and because the term 'indigenous' cannot be used as an historical locative given that practices before, during and after the colonial period may be reasonably seen as having been produced locally.

pragmatically feasible. At first sight, the case for an archaeological contribution might seem tenuous. However, any appraisal of sustainability clearly requires an assessment of the long-term consequences of a given strategy of resource exploitation, yet in the absence of this historical data, developmental narratives have both denigrated local practices in order to justify external intervention, and promoted indigenous agricultural techniques as sustainable and locally appropriate (for example Anderson and Grove 1987). Although historical information of various kinds has been employed in support of both these positions, archaeological data is rarely used. Indeed, even where the possible utility of an archaeological contribution has been discussed (for example Sutton 1989a, 1991), the form this contribution might take has not been explicitly addressed and there has thus been no attempt to think in terms of targeted methodologies.

The case study examined here has been chosen as it is particularly well suited to investigate the strengths and weaknesses of an archaeological perspective on developmental debates, since it comprises a group of agronomies that employ (or formerly employed) technologies that should be readily susceptible to archaeological investigation. These include communities that construct irrigation features such as those in the Kerio Valley in Kenya and in highland areas of Tanzania, as well as societies that employ agricultural terraces such as those in the areas of Konso and Harar in Ethiopia. The now abandoned areas of Engaruka in Tanzania (for example, Sutton 2000a), Nyanga in Zimbabwe (Soper 2002) and Marateng, South Africa (Widgren 2004 citing Maggs 1995) all employed both irrigation and terraces, albeit in different ways. Individually these 'islands of intensive agriculture' (Widgren and Sutton 2004) have been comparatively well studied although, with the exceptions of Nyanga and Engaruka, they have received little in the way of archaeological attention. As such, the history of these systems remains obscure; a situation that is especially true in those areas where the local inhabitants maintain that their community did not build all of the structures they now employ, as at Marakwet (Moore 1983) or, to take a west African example, Koyfar (Netting 1993). Despite this lack of in-depth historical detail, some writers have argued that the extant examples represent models for low external input, locally managed, sustainable resource-use as promoted by the concept of 'development from below' (Stöhr and Taylor 1981) and by the United Nation's Agenda 21 (UN 1992). In line with this approach there has been renewed interest in research that examines the sustainability of indigenous African agriculture.

In consequence, this study includes a review of the ethnographic, historiographic, geographic and archaeological literature relating to these systems in order to assess whether archaeological techniques have the potential to refine our understanding of these communities' pasts, and in doing so also presents an assessment of the feasibility of an archaeological contribution to developmental narratives. The results of recent fieldwork at the site of Engaruka, Tanzania, are presented to demonstrate how this contribution might be achieved. These results show that the system of terraces and irrigation features formerly employed at the site were completely integrated to produce a unique and sophisticated response to the problems of farming in this area, and demonstrate that relatively simple, and readily taught, archaeological techniques have the potential to precisely model the development and expansion of agricultural systems, and can do so over a longer period than the methods available to other disciplines. However, it is equally clear that archaeological studies alone cannot provide details of non-structural aspects of agricultural communities such as cropping and fallowing regimes; local institutions of resource allocation; culturally specific conceptions of causation and cosmology, or local perceptions of the 'environment' or 'climate'. Similarly, they will struggle to see and understand relatively rapid changes in resource exploitation strategies as defined for other east African agricultural communities through the detailed examination of written and oral sources (for example Anderson 1988 or Spencer 1998: 140-149). The thesis concludes, therefore, that there is a real need for a truly interdisciplinary approach to this area of study, but that such an approach should include an archaeological component.

Before reviewing the available literature on intensive agricultural practices in Africa, however, it is necessary to examine the theoretical implications of any attempt to apply archaeological data, and to outline the ways in which archaeology has been applied previously. Since the position here is that the promotion of locally developed technologies and resource use strategies requires a greater understanding of the history of local practices, it is also necessary to define what is meant by 'indigenous knowledge' and to question the archaeologically visibility of local practices of resource management. The remainder of this chapter will introduce these themes, with a view to more in-depth discussions in the chapters that follow.

Theoretical background and research context

The project takes a cultural relativist stance in terms of its theoretical outlook and, correspondingly, a substantivist position in terms of economics. More specifically, the study draws heavily upon Collingwood's metaphysics (predominantly 1940), although congruent conclusions could be reached via a more overtly poststructuralist or postmodernist position. The adoption of a relativist standpoint is perhaps unsurprising given that many proponents of the application of indigenous knowledge are effectively either endorsing the validity and utility of non-western science (for example Leach and Mearns 1996), or offering a critique of the imposition of development schemes which fail to take adequate account of local practices, institutions and conceptions (for example Warren, Slikkerveer and Titilola 1989). Indeed, many of the critiques of development that stem from social anthropology take cultural relativism as a starting point. In essence these can be viewed as saying simply that there are other ways of understanding the world, and that these may be as practically viable as our own. However, in practice this stance is often a response to attacks on anthropological authority presented via related poststructuralist, postmodernist and post-colonial debates; the argument here being that whilst problems of translation, interpretation and unavoidable methodological bias may have seriously undermined anthropology's ability to address its original ambitions, prior to coming to this realisation the discipline had developed a set of transferable skills that placed anthropologists in a unique position as potential intermediaries between the developed and developing worlds (see, for example, Hobart 1993a and 1993b).

This is not to say that the various approaches that can be broadly categorised as the promotion of indigenous knowledge are necessarily relativist, since many take the form of discourse analyses that explore the political motivations behind the denigration of local resource exploitation strategies (for example Grove 1993; Warren 1989), whilst others simply attempt to 'test' indigenous technologies and techniques, ignoring the epistemological/cosmological conceptions that may have produced this knowledge. Perhaps the most obvious examples of this latter approach are ethnopharmacology and ethnobotany but this methodology is, in theory at least, equally applicable to any process of manufacture or technique of resource management (Sillitoe 1998). Once again, the role of the indigenous knowledge specialist as intermediary or advocate has also been proposed for such circumstances, with some writers calling for the construction of 'hybrid sciences' or 'intermediate technologies' that employ components of locally produced knowledge either alongside, or modified by, western scientific techniques (for example Brokensha and Riley 1991 and Stringer 2004). Nevertheless, since recourse to the supposed supremacy of empirical science is perhaps the most common method of attacking local practices, and given that the empirical verification of indigenous techniques is effectively an act of translation, even these positions prompt comparison with a relativist viewpoint.

Although these various approaches to indigenous knowledge – and the political standpoints that have been attributed to them – will be returned to below, it is sufficient for the purposes of this introduction to note simply that they can be broadly characterised either as exercises in 'resource mapping', or as critiques of modernisation schemes and of the narratives upon which such interventions are based. At their simplest, resource mapping programmes merely record how communities use the resources at their disposal, but such studies might also note sumptuary laws, social relationships, or traditions that limit the exploitation of other resources. Superficially, as a discipline based on the interpretation of material culture, it would seem probable that archaeological techniques have the potential to contribute to studies of this sort by examining the history of resource exploitation in a given area but, as will be explored below, such projects might struggle to define the social aspects embedded within the studied economies.

The indigenous knowledge studies that explicitly or implicitly act as critiques are divided here into two general categories: the historical and the substantivist/cultural relativist. The first of these includes those studies that question the historical accuracy of assumptions regarding environments; the communities that inhabit and manage them; and the discourses that produce, perpetuate or manipulate these assumptions. The second comprises research that highlights the extent to which attempted interventions can be flawed by a failure to appreciate how they will be perceived locally. Although it would seem self-evident that archaeology has a role to play in the first of these debates, it is perhaps less clear how the discipline can contribute to the second. In terms of the historical critique, archaeological techniques can be employed to model vegetation histories; define the nature, date and extent of human impacts on environments; and should be able to assist in assessing the long-term sustainability of a particular resource exploitation strategy by examining how long a given system has been in operation and whether or not the practices employed have changed through time. An archaeological contribution to the substantivist/relativist critique on the other hand, is less direct and, it is argued here, requires a critical appraisal of archaeology's ability to define social institutions in the past. In short, if it is accepted that development schemes can be flawed by a failure to appreciate the complexity of instituted social and economic processes, so lack of access to these same social institutions limits archaeology's ability to produce accurate models of the lived past. However, in terms of the current case study, the position here is that an acceptance of archaeology's limitations is an unavoidable consequence of demonstrating the complex and dynamic nature of precolonial African agronomies, and that it is this same complexity and flexibility that has tended to be ignored or under-conceptualised by developmental narratives.

African agriculture as a dynamic and socially embedded process: implications for developmental narratives and for archaeological visibility

> Indigenous technologies are not perpetual; they change, evolve, expand, contract, and even die out. Identifying the dynamics behind these shifts should be of relevance to the planning of modern development in sub-Saharan Africa.
>
> (Adams and Anderson 1988: 531)

As will be outlined in greater detail in the following chapters, assumptions that African environments and agronomies are static remain pervasive. This goes beyond Hegelian notions of a continent without history (Hegel 1956 [1837]; compare, for example, Wolf 1982), or a belief that the practices in place at the time of colonial encounter were 'ancient' (see, for example, discussions in Koponen 1988, Rowlands 1989 and Connah 1998), to include contemporary conservationist narratives that present African environments as 'pristine', 'virgin' or 'natural' (Dahlberg 2004; Willis, Gillson and Brncic 2004). Whilst these conservationist descriptions have a clear agenda, they nevertheless imply that, at best, African communities have played no part in shaping or managing the landscapes they inhabit, and at worst suggest that contemporary populations can have nothing but negative impacts on their ecosystems. Although narratives of this sort are relatively easy to deconstruct and refute at a continental scale, to do so requires an historical perspective and an appreciation of how conflicts can arise between various interest groups (which of course include archaeologists). In very general terms, archaeological research has already done much to challenge notions of Africa as "a continent that had [...] slipped far behind in the race of progress" (Clark 1961: 112), but old prejudices persist, often long after the political or economic reasons that lie behind them had ceased to offer any obvious advantages to the states from which they originated. To borrow a phrase from Leach and Mearns (1996), these prejudicial assumptions take on the status of 'received wisdom', and challenging interpretations and models based on them may require targeted research that focuses on specific localities or individual hypotheses.

Probably the most frequently cited example of this case study approach concerns slash-and-burn shifting agriculture, where research over the last twenty years has led to a rejection of the view that such practices are necessarily destructive, and an acceptance that in some areas the technique may be not merely sustainable but actually beneficial in promoting secondary growth (Fairhead and Leach 1996a and Sillitoe 1998: 224 citing Warner 1991 and Dove 1981). By demonstrating that areas of 'virgin' forest had formerly been employed for shifting cultivation, research of this kind provides a striking example of how a short-term perspective can present a radically different picture to one that is based on an examination of historical context and change. Similar cases have been made for indigenous approaches to soil and water conservation (Reij, Scoones and Toulmin 1996) and for nomadic pastoralism (Anderson and Grove 1987 particularly Hogg 1987 and Homewood and Rodgers 1987), where conservationist narratives that saw this specialised strategy as being sufficiently damaging to call for massive de-stocking programmes, have been countered by arguments that espouse its essential role in savannah ecologies.

Although the current project endorses this case study based approach and argues against the unquestioning application of generalised developmental models, it is nevertheless possible to broadly define several themes that need to be considered if an assessment of the sustainability of a particular agronomy is to be made. Clearly, to think in terms of the sustainability of a given strategy is to simultaneously approach the study of systems of land management diachronically and indeed, once it is acknowledged that all agro-ecosystems are inherently unstable (Lambert 1985) it becomes impossible to think of any agronomy as totally inflexible and static. That is to say, it is precisely because agronomies are not natural that they require constant management through the utilisation of techniques that can respond to changing conditions such as rainfall or temperature variability. Communities therefore develop a repertoire of potential responses to given conditions which in time form part of their traditional knowledge and become embedded within other social institutions. However, this same traditionalism and lack of clear separation between social and economic components within communities has been employed to suggest that African agronomies are unresponsive and irrationally resistant to modernisation (see, for example, discussions on the modernisation and expansionist schools of development presented in Gregory and Altman 1989 and Patterson 1994). As a result, if a more realistic picture of the dynamic nature of African agriculture is to be presented it is necessary to demonstrate the degree of change evidenced historiographically, ethnographically and archaeologically, and to examine critically the political and ideological motivations that have contributed to the view that African agriculture is static. However, as was briefly noted in the preceding section, highlighting the significance of historical and institutional factors also raises questions regarding their archaeological visibility.

Perhaps the most obvious misconception regarding African agronomy that requires explicit exposition is the rejection of the view that 'traditional' community subsistence strategies are fixed and form an essential element of group identity. The roots of this misconception undoubtedly lie with the policies of colonial governments that sought to identify groups and group leaders that matched their preconceptions of tribal chiefdoms (Ranger 1983 – who also notes that groups within several African societies recognised this expectation and deliberately manipulated it), and with early twentieth-century comparative ethnography that often regarded subsistence strategies as one of a small group of societal characteristics that could be recorded unproblematically (Fardon 1988; see for example Fortes and Evans-Pritchard 1940). However, ethnographic and historical research over the last twenty to thirty years has increasingly highlighted the extent to which categorisations along the lines of 'the Maasai are pastoralists' have tended to mask variability within societies, and under-emphasises the extent to which whole communities can change their subsistence strategies over relatively short periods. The Bena, for example, changed from grain-cultivation and cattle-herding to a subsistence pattern based on rice and fish between the late 1870s and the early 1930s (Koponen 1988: 384 citing Culwick and Culwick 1935). Similarly, in response to markets created by the caravan trade, the Chamus of Lake Baringo, Kenya, massively expanded an irrigation system that appears to have originally formed part of a risk-mitigation strategy within a predominantly pastoralist economy, to the point where it became an essential element of specialised grain production. This process of expansion and intensification started in approximately 1840, reached a peak in the early 1870s, and had been largely abandoned by 1920 (Anderson 1988; Adams and Anderson 1988). Indeed Chamus oral tradition, particularly as regards the foundations of clans and age-sets, records that although they speak Maa and operate Maasai social institutions, the community had formerly based its subsistence on hunting and gathering, later adopting the trappings of their pastoralist neighbours whilst retaining aspects of their identity as, in Maasai terms, 'Dorobo' foragers (Spencer 1993). Matundu (1999) discusses a similar example of subsistence strategy change that occurred as recently as the 1930s when Mukogodo hunter-gatherer communities living in highland areas of Laikipia, Kenya, abandoned the habitation of rockshelters and a diet based on meat and honey for an economy based on stock-rearing and settlement within Maasai-style houses; a change of lifestyle that also included the gradual loss of their former language (Yaaku) in favour of Maa.

The example of the Chamus adoption of intensive, irrigated agriculture in the nineteenth century is also cited by Mace (1993:369), who places added emphasis on trade webs, reciprocal exchange and institutionalised migration between the Chamus and neighbouring pastoralist groups. Although archaeologists are accustomed to thinking in terms of complex webs of interaction across culturally dichotomised boundaries (for example Hodder's study of the Njemps [Chamus], Pokot and Tugen in the Kerio Valley, Kenya – 1982), and even the extent to which neighbouring groups can have shared 'symbolic reservoirs' (MacEachern 1994), the fluidity with which individuals can move between different 'ethnic' groups, adopting new subsistence strategies and material cultures without changing their oppositionally-defined identity, has tended to be ignored as a significant (and archaeologically invisible) factor in models of agricultural change. This issue will thus be returned to in chapter 4, where particular emphasis will be placed on the degree to which transitions of this kind can be seen as an aspect of complementary niche exploitation (see, for example, Haaland 1969 and McCown, Haaland and de Haan 1979).

What appears to make these inter-'ethnic' transitions more remarkable is that, in agricultural terms, these groups might be seen as operating the opposite of their neighbour's economies and, correspondingly, are likely to configure value in different ways. Indeed, although Guyer's (1993) concept of continuous value registers stresses the socially embedded and polythetic nature of value categorisations, and emphasises that individuals' skill at 'playing' registers can both manipulate material valuations and affect social or 'moral' hierarchies, at its simplest the model suggests that communities will tend to configure value in terms of a single category of object. At this basic level the concept is similar to stage four of Simmel's (1978 [1907]) 'process of objectification', with the additional recognition that objects can retain use-value but be periodically socially commoditised (Appadurai 1986). Without wishing to include a lengthy critique of the 'wealth in people' hypothesis (Meirs and Kopytoff 1977) at this stage, even if one were to strategically essentialise African agricultural systems into those that build value registers around cattle and those that base value categorisations on land, there is no clear correlation between subsistence strategy and value foundations, perhaps as a result of the kind of community-wide shifts in cultivation strategies or the inter-'ethnic' transitions outlined above. Communities in the Pare Mountains of Tanzania, for example, employ irrigated agriculture but maintain (or perhaps retain) a system that configures wealth in terms of cattle (Håkansson 2002 and Sheridan 2002). Based on material evidence alone, it is not possible to discern which of these generalised categories an agronomic community adopted at any given time, yet assuming one or the other, dramatically affects how responses to changing conditions are interpreted. In terms of now wholly abandoned agricultural complexes like Engaruka in Tanzania, for example, if agricultural intensification led to the accumulation of large herds of cattle, the abandonment of the system could be interpreted as a result of the agronomy's success.

Problems of this kind of archaeological modelling are most obvious when non-western conceptions of causation are considered. This goes beyond questioning the assumption of a maximising rationality, and requires the recognition that communities may react to changing conditions in ways that are quite inconsistent with the technological and physical approaches to causation that are characteristic of western science (Collingwood 1940, Sperber 1982 and Needham 1976). For example, the fact that several specialised or intensive agricultural communities in Africa see 'the environment' or climate as entities susceptible to cosmological intervention and partially base political authority on the success of this manipulation (for example Meru, Tanzania – Spear 1996; Waluguru, Tanzania – Maack 1996), has a clear bearing on models that aim to interpret societal responses to changing circumstances. This direct causative link between political/religious authority and climate was recognised by Fortes and Evans-Pritchard (1940) and formed a central tenet of Feierman's study of the social history of Shambaa, Tanzania (1990), but it should be highlighted that the idea remains prevalent in both rural and urban populations. Gewald (2001), for example, notes how poor rains in Botswana in late 2000 were blamed on perceived governmental misuse of recently repatriated human remains, whilst Sheridan (2004) records that in 2002 police in Niger attempted to prompt rain by arresting prostitutes.

The issue of causation has a clear bearing on the relativist stance adopted here, and as such will be returned to in the following chapter where the related epistemological issue of economic substantivism will also be touched upon in terms of the difficulty of separating technologies from the epistemologies that produced them. However, the degree to which economic institutions are socially embedded and thus defy simplistic methodological sub-divisions such as 'religion', 'hierarchy', 'economy', 'technology', is at the heart of the substantivist critique of the exportation of neo-classical economics and, as such, substantivism also forms an element of the discussion of discourses relating to African intensive agriculture presented in chapter 4. Though often seen as merely a product of 1960s economic anthropological debate (see, for example, Polanyi, Burling, Cook, Dalton and LeClair, all in LeClair and Schneider 1968), the insights arising from an institutional approach to economics resurfaced in the 1990s as an aspect of what amounts to a relativist response to globalisation (Hobart 1993b), and remains significant from an archaeological perspective in terms of problems inherent in theorising non-rational behaviour and as a counter to normative models of the adoption of agricultural practices. Nevertheless, as with the other generalised perplexities outlined above, problems of archaeological visibility of what are potentially extremely pertinent social factors, render the creation of 'accurate' reconstructions of the past extremely difficult to achieve with any degree of confidence. The traditional archaeological response to this problem is to search for ethnographic analogies that are as 'relational' (Hodder 1986) as possible. It should be clear, even from the brief summary presented by way of introduction here however, that a dynamic view of African agriculture makes it possible to identify multiple parallels with radically different ramifications in terms of models and interpretations (see also Stahl 2001: 222-3).

The theoretical aspect of the current project includes an attempt to address the dilemma presented by this recognition. That is to say, in highlighting the dynamic nature of African agriculture and the difficulty of attempting to theorise economic activity as if it were alienable from other social institutions, it becomes clear that there are serious limitations in terms of understanding and modelling the resource exploitation decisions made by past societies. Indeed, from an archaeological perspective, it matters little whether or not one assumes that all societies are, at heart, rational, if the decisions communities make are based wholly or partially on conceptions that are archaeologically invisible. As will be discussed in the following chapter, this is very far from being a purely archaeological concern, but it is clear that the nature of archaeological data exacerbates the problem. This is not just a case of acknowledging that the kind of transitions summarised above mean that it is possible for a community to effectively disappear from the archaeological record; this is, after all, accounted for by good old fashioned diffusionism and is a practical, rather than theoretical, concern.

Instead, the problem results from the recognition that archaeological or historiographical models are always plausible accounts of a series of decisions made by past communities, even when these decisions would not themselves be seen as having been based on plausible conceptions from an archaeological or historiographical point of view. The fact that differing socially constructed conceptions of time and causation will inevitably lead to mutually contradictory constructions of 'the past', merely adds a further layer of complexity to this issue.

There is thus a theoretical concern that needs to be addressed, and although it is one that is highlighted by the ambitions of the current project, it is also one that affects any attempt to reconstruct the history of communities that either do not, or may not, share an epistemology with archaeology or historiography. It is thus a question that has wide archaeological repercussions, but it is most commonly discussed from the perspective of the problem of reconciling – or the impossibility of reconciling – different accounts of the past: how can a rational/empirical discipline account for non-rational behaviour or the behaviour of communities that have differing conceptions of time or causation? The position here is that, on the basis of physical archaeological evidence alone, accounts of this kind are likely to be highly speculative. The dilemma for archaeologists, therefore, is how to reconcile a relativistic appreciation of the impossibility of achieving a consensus between conflicting socially constructed pasts and a (admittedly culturally programmed) confidence in a localised strategy for producing historical knowledge that appears, albeit auto-referentially, to achieve a degree of success. The response to this problem advocated here is that an applied archaeology could shift the criteria of 'success' away from plausibility and towards functionality. In terms of on-site methodology this shift in emphasis need not have a major effect on the techniques employed or, indeed, on the types of questions asked. Inquiries such as 'how old is this system', 'how did it develop and operate', 'how many people did it support' and 'was it sustainable' are all questions we would expect archaeologists to ask of an agronomy, and all have a clear bearing on developmental debates in terms of whether they refute or support established narratives. The realignment of perspective endorsed by the current project, moreover, permits questions of this sort to be pursued despite the fact that the presence of archaeologically invisible factors make it extremely unlikely that the process will produce 'real' pasts recognisable to those that inhabited the systems under investigation. Nevertheless, regardless of the perspective taken, the questions outlined above have not been adequately addressed in the case of most African agricultural sites. The fieldwork undertaken over the last two seasons has been an attempt to begin to redress this situation.

The function and potential application of archaeology

> In many cases, archaeological and traditional systems may be more sophisticated, more environmentally sound, more culturally appropriate, and more productive than those introduced from outside. [...] An approach that combines basic archaeological techniques with agricultural experimentation not only can yield many insights on now-abandoned agricultural features, but may also provide models for present day rural development in landscapes where archaeological remains of cultivation systems are found.
>
> (Erikson 1994: 147)

In examining the desirability and feasibility of employing archaeological techniques to qualify debates surrounding rural development, it is not the intention here to argue that this is the only potential application of archaeological methods. For one, archaeology obviously retains its position as a route to defining past events, but this is the discipline's intended function rather than its application. However, archaeology's success at performing this function has a clear impact on how, and under what circumstances, it can be applied. For example, in terms of the discipline's application in educational – rather than vocational – training, the subject's requirement that its practitioners continually question the presuppositions of themselves and others is arguably more important than the production of definitive statements about the past. That is to say, in applying archaeology (or indeed any discipline) as an educational device, the subject performs a role beyond its original function, and it is upon its ability to achieve this secondary function that its success is gauged. The issue of education is, therefore, not entirely tangential to the current study as it is an established method of applying archaeology which also offers capacity building potential through the teaching of transferable skills. However, as a recognised means of applying archaeology it requires little further explanation here. The use of archaeological materials and sites for tourism, in contrast, does have a direct bearing on the present study because any attempt to employ the insights from the examination of indigenous agricultural practices would need to address issues of cultural ownership and of archaeological preservation and representation, all of which are questions that have previously been explored in relation to the development and promotion of heritage tourism.

Although issues raised by the use of sites as visitor attractions remain contentious and often require case-specific responses (for example Pwiti and Mvenge 1996, Segobye 2004), heritage tourism nevertheless continues to be the most obvious and direct way in which local communities can profit from nearby archaeological sites. However, it is questionable whether this approach is applied archaeology at all, or simply the presentation of material that also happens to be employed by archaeologists as evidence. Archaeologists are, therefore, an interest group in terms of both heritage tourism and the broader debates of 'heritage resource management' (itself a term from a discourse dominated by archaeologists), however much they (we) might present themselves as objective arbiters and, as such, conflicts between rights of access and issues of preservation are inevitable. Indeed, problems of this kind are likely to be most acute within societies that do not share the epistemological standpoint inhabited by archaeology and where individual communities identify with specific archaeological sites; a problem that can be exacerbated still further if government policy favours, or has been pressurised to support, the dominant paradigm of preservation as endorsed by various international conventions (for example UNESCO 1985, ICAHM 1990).

Defining the changing nature of archaeological involvement in debates regarding heritage tourism requires a more detailed discussion than need be presented here, but the origins of this relationship can be seen primarily as a consequence of the subject's long-standing association with museums. As institutions that display the material indices of humanity's past to a predominantly non-archaeological audience, museums form the boundary between archaeology and other types of heritage tourism, and indeed have been presented from an archaeological perspective as the benchmark for the presentation of 'heritage', to the point where alternative approaches are denigrated as the products of 'heritage mongers' or as "the past Disneyfied into pap" (Lowenthal 1994: 306). There are a clear set of value judgements in statements of this kind which centre around notions of 'authenticity'; a concept which itself requires a belief in some sort of intrinsic value to 'the past' since the only thing the inauthentic lacks is a connection, however intangible, to this inaccessible quality. This is not just a question of rarity and supply and demand (though this is undoubtedly often a factor), because many categories of artefact are sufficiently plentiful to be rendered practically worthless in monetary terms yet retain their status as genuine historic objects. Similarly, the perception of their worth cannot be based purely on their use-value as pieces of archaeological evidence, because if this were the case they would become worthless once they had been adequately recorded. From this perspective, therefore, museums can be seen as an archaeological obligation, rather than an application: once uncovered, the conservation of fixed or portable antiquities becomes the responsibility of those who have thus threatened their preservation. All other museum activities are either aspects of this imperative, or are an extension of archaeology's long-established role as an educational tool.

This is not to say that museums cannot play a role in economic and social development, either as a means to "creating conditions conducive to the growth of people's self esteem" (Todaro 1997: glossary), or through direct intervention at project level. Grant (1994), for example, reports on a project initiated by the Phuthadikobo Museum in Botswana that created a silkscreen printing workshop, whilst Segobye (2004) discusses how networks of local museums in Botswana and South Africa have been employed to promote awareness of HIV/AIDS. Although projects of this sort are, of course, to be applauded, they are not the result of the application of archaeology per se, and are instead the use of established infrastructures which are themselves a consequence of research from a variety of disciplinary perspectives, of which archaeology is just one. A true application of archaeology, in contrast, should not be ancillary to the discipline's function but should be a product of it. Moreover, it should result from the use of archaeology, as opposed to a use of 'the past' and, if it is to be practically viable, should improve the chances of a given project's success.

Under the above criteria, much of what might be thought of as applied archaeology needs to be reassessed. Sites revealed by, or which have been the subject of, archaeological research, might be visitor attractions but this is rarely if ever the primary reason behind their investigation. Indeed, part of the obligation felt by archaeologists to present their findings to the wider public in an open and realistic way is a result of a need to be accountable to other archaeologists and to sponsors. Any legislative protection of heritage resources, regardless of whether public funds are made available for this protection, amounts to state sponsorship which will, in turn, require that the state demonstrates to the wider populous that this endorsement is achieving results. In accepting the mantle of 'heritage managers' the onus on demonstrating the success of government policies aimed at preserving the material remains of historical events is passed back to archaeologists. Rescue archaeology, or archaeological mitigation strategies as planning constraints on commercial developments are, therefore, not applications of archaeology: they are just archaeology. However much archaeologists might present such strategies as historical conservation for the good of the public, in the public's name, they remain simply a reflection of archaeologists' desire to get on with the function of archaeology. Arguments that heritage management is in itself an application of archaeology (for example Cleere 1989 and 1993, Darvill 1999) tend, therefore, to be somewhat circular. Thus, although Darvill (1999) notes that the material remains of humanity's past have 'use values', 'option values' and 'existence value', and that archaeology is only one of several possible 'uses', he goes on to assert that a societal obligation to afford future generations similar options as regards our shared heritage means that this material needs to be preserved. The professionals most qualified to ensure this preservation, it is argued, are archaeologists (ibid.). This apparent conflict of interest is by no means a covert conspiracy, but it is a disciplinary obligation presented as a societal imperative; a luxury presented as a necessity (Wylie 2005: 55). We are back where we started with Childe's "I like doing this and my society pays me quite well for doing it" (1956: 127).

A similar case can be made for the various attempts to add contemporary relevance to the discipline on the basis of the somewhat trite formula 'without knowing the past you cannot know the present' such as:

> The impulse to preserve the past is part of an impulse to preserve the self. Without knowing where we have been it is difficult to know where we are going. The past is the foundation of individual and collective identity, objects from the past are a source of significance as cultural symbols.
>
> (Hewison, 1987, cited in Rowlands, 1994: 130).

As will be returned to below, this is an idea that has currency within society more generally, and receives support from a variety of political or methodological standpoints. However, the problem here is not that arguments along these lines lack foundation or are internally flawed. Rowlands, for example, employs the above citation as a starting point for a discussion of Enlightenment thinking on the spatial and temporal underpinnings of identity (specifically in the writings of Locke and Hume), and goes on to examine the centrality of individual and group histories in the psychological approaches to identity and identity loss taken by Freud (passim) and Erikson (1959 cited in Rowlands 1994). One might also approach this same question via reference to the role of myth and history as discussed by Levi-Strauss (for example 1973), or through Durkheimian notions of the societal creation of group identity by means of, amongst other things, the teaching of cultural history (Durkheim 1961 – [1915]); both of which are concepts that can be reversed to highlight crises of identity engendered by some form of enforced separation, be that through migration, Marxist alienation or Durkheimian anomie (1984 – [1893]).

In terms of the current discussion, the problem with presenting these approaches as applications of archaeology is that identity constructions of this kind are based on perceived pasts which need not bear any real relationship to the pasts constructed by historians and archaeologists. Thus, whilst Hobsbawn might be right to assert that "we provide the essential raw materials for the market" (Hobsbawn 1992: 3), these materials are thereafter shaped into commodities as required and, moreover, retain the potential to be infinitely re-cycled and re-used. Although it may sometimes appear that the degree to which pasts can be manipulated is mitigated by archaeological or historiographical interpretations, this often represents the deliberate appropriation of an academic idiom in an attempt to add authority and authenticity. Examples of the direct use of archaeological data in identity constructions are correspondingly extremely rare, and where they do occur these might be better characterised as the political application of archaeology (see, for example, discussions on the political use of Great Zimbabwe presented in Garlake 1973, Hall 1990 and Kuklick 1991).

Clearly, the point raised above regarding the need for an applied archaeology to improve the chances of a project's success depends entirely on the criteria by which this success is gauged. This point can be illustrated by returning briefly to the issue of the promotion of heritage tourism. Whilst some visitor attractions can be seen as the direct result of archaeological research (for example Addyman 1994), archaeological obligations to make it explicitly clear what is original and what is reconstructed; the reasoning behind any reconstructions; what evidence has been employed in reaching interpretations, and the methodology used to assess this evidence, render the creation of archaeologically-based tourist attractions considerably more difficult to achieve than the simulacra of American 'wild west towns' or African 'lost cities' (Hall 1995). If the primary motivation behind an attraction is its profitability, therefore, adherence to archaeological notions of evidential constraint and site preservation risk dramatically reducing the chances of the project's success. Although archaeologists may feel uneasy at the thought of profitability as the principle objective of heritage tourism, the reasons for this disquiet can be seen, yet again, as manifestations of the disciplinary imperatives outlined above. From an archaeological perspective, to say that commercial gain should not be achieved at the expense of the 'accurate' representation of the past, is the same as saying that heritage tourism projects must adhere to archaeological notions of evidential constraint and, by extension, should not miss the opportunity to help fulfil archaeology's secondary function as an educational tool.

It is difficult not to notice, moreover, that this responsibility is often interpreted by archaeologists as a need to educate those outside of the discipline of the 'important' and 'necessary' function that archaeology achieves (Miller 1980). However, it would be wrong to see archaeological objections to specific heritage tourism projects as being solely based on an attempt to claim a disciplinary monopoly on the verification of the 'authentic', since archaeological opposition to the presentation of the 'inauthentic' can include attempts to tackle the potential political ramifications of such displays. Thus, Nzewunwa (1994) and Van Schalkwyk (1996) employ examples drawn from west Africa and South Africa respectively to discuss the issue of whether marketing African heritage tourism towards foreign visitors and the urban bourgeoisie risks distancing poorer communities from nearby sites, whilst Spiegel (1994), Kinahan (1995) and Ucko (1995 and 2004) cite examples of the promotion of heritage tourism in South Africa, Namibia and Zimbabwe which, through the use of tours of 'traditional villages' and the incorporation of contemporary dancers into rock art displays, could be construed as implying that modern communities and practices have not changed in centuries.

Yet just as this association between contemporary and archaeological remains risks reinforcing certain stereotypes, the discussion above regarding the use of perceptions of the past in identity constructions serves to illustrate that many individuals or communities do identify with the materials that form archaeology's primary data source, and may view archaeological attitudes to these objects or sites as inappropriate or as an attempt to commandeer cultural property (see for example Layton 1994a and 1994b). Undoubtedly the most commonly cited example of this potential conflict between local and archaeological priorities concerns the repatriation of human and artefactual remains (Layton 1994b), but in the context of the current discussion this issue has a greater relevance in terms of the challenge it represents to notions of archaeological 'stewardship' of 'heritage resources', and because the concept of 'cultural property rights' has a direct impact on studies of 'indigenous knowledge'. Indeed, in discussing the implications to archaeology of the use of copyright laws by local communities, Nicholas and Bannister (2004: 334) note that these two issues are closely related in that it is possible to argue that indigenous knowledge "includes not only the intellectual tradition itself (i.e., the information preserved and transmitted) but also the traditional use sites that are the geographic expressions of that knowledge". Such a definition would certainly encompass archaeological sites or technologies defined through archaeological evidence, and indeed the interrelationship between 'heritage' and 'indigenous knowledge' is recognised from the other direction by the United Nations Educational, Scientific and Cultural Organisation which has defined 'intangible (or living) cultural heritage' as comprising "oral traditions and expressions, including language [...]; performing arts; social practices, rituals and festive events; knowledge and practices concerning nature and the universe; [and] traditional craftsmanship" (UNESCO 2003, also cited by Siller 2005: 85).

Although currently a rare occurrence, it is thus likely that archaeologists, historiographers and anthropologists will continue to be called upon to act as expert witnesses in cases that seek to assess the validity of land claims that are based on either indigeneity or length of occupation (Siller 2005: 73 and 83; Hall 2005: 172-4), or where claims to cultural property rely on establishing when and where a given technology, cultivar or artistic representation was first employed (Nicholas and Bannister 2004: 335 and 340-341; Siller 2005: 86-7). The recent successful negotiation of future drug royalties on behalf of San communities in South Africa serves as a useful example of just such a case, since it was argued that the development of a dietary aid based on the Hoodia cactus was prompted by local use of the plant as a hunger suppressant (BBC 2003). Indeed, it is interesting to note that the reporting of this case makes reference to the San having consumed the cactus 'for thousands of years' (ibid.), a claim that is neither provable nor necessary in this instance. Nevertheless, it is not difficult to imagine that archaeological evidence could be employed in similar cases[2]. The use of archaeological data in this way would thus represent a true application of archaeology under the criteria defined above, and may also become increasingly common as individuals and corporations seek to establish national and international patents for genetic (or for genetically modified) material (Nicholas and Bannister 2004; Siller 2005: 86-7; Stone 2005: 206-8).

However, as was briefly touched upon earlier, archaeology's position of authority within legal debates is ultimately based on the fact that an increasingly globalised Western legal system shares an epistemology with Western science, particularly as regards conceptions of time, causation and evidential constraint (see, for example, Keesing 1990, and the discussion of this case study in the following chapter). It is this shared epistemology that accounts for the ease with which archaeological conceptions and techniques have been incorporated within legislative protection of heritage resources, and thus it is also this shared approach to causation and evidential constraint which suggests archaeology may be able to contribute to questions of cultural ownership. Yet the possibility – or indeed the likelihood – that the communities seeking to establish claims to cultural property will employ differing conceptions suggests that this relationship will not be unproblematic. Since this question of epistemological incommensurability has a clear bearing on the current study it will be returned to below. Before doing so, however, it is worth briefly considering forensic archaeology as one final example of the application of archaeological techniques which, like several of the examples above, results from similarities between legal and historical approaches to the reconstruction of past events.

Whilst it is possible to argue pedantically that forensic archaeology is simply the archaeology of the recent past, there is little doubt that the objectives of this sub-discipline are directly targeted towards an application that is beyond archaeology's original aims and is a response to a demand for information that originates from outside the discipline. As with education, it is this realignment of intended outcome that makes forensic archaeology an application rather than an ancillary obligation. Furthermore, it is clear that since the intention of forensics is to improve the court's ability to define the nature of the events in question, this approach fulfills all of the criteria for an applied archaeology as outlined above. Like education, however, forensic archaeology is now well established (see, for example, Hunter, Roberts and Martin 1996; Hunter and Cox 2005) and is beyond the scope of the current paper.

[2] Although the term palaeoethnobotany (or paleoethnobotany) has been used by environmental archaeologists since at least 1959 (Pearsall 2000: 2 citing Helbaek) there is no established tradition of applying, or seeking to apply, this information as there is with ethnobotany or ethnopharmacology (for example Cotton 1996; Cunningham 2001). Instead the term is defined very broadly as "the analysis and interpretation of the direct interrelationships between humans and plants for whatever purpose as manifested in the archaeological record" (Ford 1979: 286 cited by Pearsall 2000: 2).

The intention here is not to dismiss these pre-existing applications but is merely to point out that the other apparent uses of archaeology discussed in this section arise from disciplinary obligations, or are a result of applications of 'the past'. Education and forensics, in contrast, are quite different in form because, rather than seeing archaeological evidence as the resource, they place their emphasis on, and draw their authority from, the methodology of archaeology.

By way of summary then, this section has attempted to explore briefly the ways in which archaeologists have applied the discipline, and in doing so has questioned the presentation of disciplinary obligations as if these were practical applications of archaeology. These obligations are not all unique to the subject but the unusual nature of archaeological source material, and the techniques used to retrieve it, have allowed practitioners to present themselves as stewards of the past (Wylie 2005). Thus, although all subjects consider the accurate and honest dissemination of results to be a responsibility, archaeologists have long argued that the discipline feels this imperative more acutely because excavation – arguably the subjects defining technique – is an 'unrepeatable experiment' which, in the process of gathering information, destroys contextual data. By borrowing heavily from concepts first employed within environmentalist and conservationist discourses, this idea is now more commonly expressed by referring to all potential categories of archaeological evidence as non-renewable resources (Darvill 1999, Macinnes and Wickham-Jones 1992). This nomenclature creates what appears to be a 'green' dimension to the disciplinary imperative towards heritage conservation, but with the crucial difference that the mere act of recording the resources that are under threat is not seen as an adequate mitigating measure when dealing with the destruction of other non-renewables. The archaeological concept of 'preservation by record', in contrast, treats information as a resource that not only explains and interprets its source material, but which also acts as a substitute for it. This same concept cannot be applied to the types of non-renewable resources to which environmentalist narratives commonly refer.

Seen in this light it is clear that the term 'heritage resource management' employs the word 'resource' in a way that is quite different from the manner in which it is employed by environmental conservationists. Indeed, since it refers to both in situ archaeological data (whether known or unknown) and the existing body of all previous archaeological studies, the term is really being employed in the sense of 'a stock of material that can be drawn upon'. But drawn upon for what? The past may be treated as a set of precedents to guide or justify actions, and undoubtedly is used in identity construction, but how often are these processes undertaken following the consultation of archaeological reports? In effect, archaeologists employ the term 'resource' rhetorically as a means of associating 'heritage management' with conservationist narratives, and to imply that this material has multiple uses. In reality, however, the resource is only drawn upon by those with an interest in archaeology. Hodder (1997: 13), for example, discusses the different ways in which the 'archaeological resource' has been treated by processualist and rescue archaeologists but in both instances the term is treated simply as if it were a synonym for 'evidence'. Of the various possible applications of archaeology discussed above, only education and forensic archaeology are established methods which draw upon the resource in this way before re-applying it to fulfil a secondary function.

If the information gathered by archaeologists is ever to "increase the production of bombs or butter" as Childe envisaged, the archaeological resource would have to behave in the sense of 'a means to supply a want'. It is in this sense that 'indigenous knowledge' is treated as a potential developmental resource. However, as was noted above and will be returned to in the following sections, the proponents of indigenous knowledge have tended to present local strategies and technologies as potentially paradigmatic without fully understanding the long term history of the communities that employ them. Since there is clearly a temporal element to assessments of sustainability, it should be possible to employ the archaeological resource in the sense of 'a stock of material' in order to question these assumptions. It could be argued that this would also make archaeology 'a means to supply a want', although in such circumstances the demand for this information would be at the level of developmental narratives and, perhaps, developmental project design. For archaeology to act as a means to supply a want in its own right, it would need to be able to demonstrate an ability to accurately define modes of resource exploitation in the past, and to identify areas where these could be productively re-employed.

As the quote that heads this section demonstrates, some archaeologists have discussed the possibility of an archaeological contribution to development schemes, and indeed projects have been attempted in which abandoned technologies defined by archaeologists have been re-built and re-used (for example Erikson 1985; Kendall 2005; Spriggs 1981 – see below), whilst the possibility of basing development initiatives on abandoned systems has also been explored by engineers (for example MacDonald 1960). In the context of the discussion presented here, such projects represent a true application of archaeology in that their objectives are focussed towards economic benefits in the near future rather than towards, to paraphrase Childe, 'the gathering of information about the behaviour of men long since dead'.

Archaeology as a means of defining indigenous knowledge

> Many semi-arid areas are the heartlands of agriculture, and the lessons learned from millennia of food production in these often difficult environments can provide critical information for understanding the past. Perhaps as importantly, we can use knowledge of the astounding range of prehistoric agricultural strategies and their ecological effects to build a more sustainable future, especially where food production expands into unfamiliar and unfavourable locations.
>
> (Minnis 2000: 271)

The idea that archaeological studies of how communities managed their resources in the past may have beneficial applications in the present is not new. Indeed, to judge from statements made by many of the authors working in this subject area, one might be forgiven for assuming that the implications of this stance had been explored in detail and that the desirability of the position was self-evident. Comments to this effect have been expressed by, for example, Andah (1995a), Gleason (1994), L.S.B. Leakey (1936, cited in Niemeijer 1996), Richard Leakey (1991), Morris (1999), Nicholas and Bannister (2004), Schmidt (1989, 1994 and 1995), Weiskel (1989), Wheeler (1967), and by many of the contributors to volumes by Farrington (1985b), Sutton (1989) and Barker and Gilbertson (2000a). However, although a limited number of archaeological projects have explored the possible developmental implications of this line of enquiry based on fieldwork in South America (Erikson 1985, 1993, 1994 and 1998 [1992]; Kendall 1997 and 2005) and in the Pacific (Spriggs 1981), questions of this kind have not, to date, been one of the primary objectives of African archaeological research. Nevertheless, the topic has been afforded discussion by archaeologists (Sutton 1989 and 1991 and Kinahan 2000), historians (for example Anderson 1988 and 1989, McCann 1990 and 1999a) geographers (for example Adams 1989 and Widgren 1999) as well as by numerous anthropologists (see, for example, Fleuret 1985, Moore 1983 and 1986, and van Beek 1993).

For the main part, however, the archaeological contribution to these debates has been conceived as a secondary consideration, with archaeologists employing the concept largely rhetorically to add contemporary relevance to their research, whilst archaeologists and non-archaeologists alike cite the idea as a means of adding temporal depth and context to research from other disciplinary backgrounds. The quote that heads this section is perhaps typical of this somewhat rhetorical approach: the notion that there may be some practical application to studies of prehistoric agricultural practices is given prominence in the article's opening paragraph, but is nevertheless regarded as a secondary concern (note the phrase "perhaps as importantly"). Moreover, there is no attempt to address the issue of how this archaeological data might be applied, or who will apply it (beyond a pleasantly inclusive "we"), though the potential utility of the work is emphasised by reference to an ongoing problem and implied future crisis. Typical though it may be, the mere raising of the issue of possible later application still sets the writer apart as one of only a handful of archaeologists prepared to consider the potential usefulness of their research to others outside the discipline.

This reluctance to specify exactly how archaeological research might be applied is quite understandable, since a more detailed analysis could be seen as commenting on an area of specialised research that lies well beyond that of the writer's own competence. However, there are a series of levels at which, theoretically at least, an archaeological contribution to developmental studies could be made. The first of these might simply involve an engagement at the level of developmental discourse by exploring the historical accuracy of the premises and paradigms upon which developmental models are based, either through an examination of the existing literature on such paradigms or via the initiation of research targeted towards the areas or technologies cited within these debates. At a greater level of involvement, archaeologists might experiment with, and even promote, the potential utility of archaeologically defined technologies or techniques, in a manner akin to the anthropological participation with so-called 'intermediate technologies'. Finally there is the possibility of direct in situ re-use of resources or techniques of resource exploitation that can be shown to have been exploited in the past but which have not been employed subsequently. Examples exist of projects that offer contributions on all these levels but, although many of these are historical in terms of perspective, archaeological studies in this area remain uncommon.

Involvement at the first level has already been touched upon above and echoes the approach endorsed by Niemeijer (1996) who argues that developmental attitudes towards African agriculture continue to be influenced by the view that precolonial resource-use strategies existed in a state of equilibrium, and that to counter this belief "requires a shift from a synchronic approach to a diachronic approach that is firmly based on an understanding of the past" (1996: 87). However, perhaps the most cited proponent of the inclusion of an historical dimension to African developmental narratives – Juhani Koponen – writes from a disciplinary background in development rather than historiography or archaeology, and indeed has been criticised for failing to interrogate his source material with the vigour expected of a professional historian (Waller 1991). Nevertheless, Koponen's (1988) study of precolonial agricultural communities in the area of what is now Tanzania serves as a rare example of an attempt to draw together a variety of historiographic and ethnographic case studies in order to specifically address questions arising from developmental discourses.

Although attempts to qualify the assumptions within developmental narratives through the collation of case studies may be rare, research focussed towards the production of such case studies is becoming increasingly common. Moreover, as was noted in the opening section to this chapter, many of these studies employ a temporal element to support their findings, though the time-scales and sources employed vary widely. To take studies of forest management as an example, Fairhead and Leach (1994, 1996a and 1996b) have used a combination of aerial and satellite photographs, eighteenth- and nineteenth-century travellers' accounts, and oral histories to question the belief that local practices in Kissidougou, Guinée, were leading to forest degradation. Boerma (2004) employs a similar methodology to examine conflicting views of deforestation in the Eritrean highlands, whilst Eshetu and Högberg (2000) have used measurements of carbon13 isotopic levels in soils to reconstruct forest vegetation histories in the Ethiopian Highlands, and in doing so question whether historical fluctuations between forests and grasslands support the assumptions of current large-scale tree planting programmes. At a far greater time-depth, pollen sequence analyses have been used to reconstruct forest clearance episodes in the highlands of Uganda, Rwanda and Burundi over the last 20,000 years (Jolly et al 1997, Marchant 2003), and have also been employed to question possible relationships between ecological change and political developments in the late precolonial period (for example, Taylor, Robertshaw and Marchant 2000).

None of the categories of evidence employed in these case studies are unfamiliar to archaeologists and indeed, in the case of the palaeoenvironmental approaches, the discipline has been actively involved in the development of the techniques of data recovery and analysis. Thus, studies of this kind not only help illustrate what an archaeologically-based project might look like, but also aid in assessing where archaeological techniques and categories of evidence might be employed to assist within multidisciplinary projects. Mapunda's (2003) study of precolonial iron smelting practices in Kondoa, Tanzania, is a good example of just such a contribution. The project combined the archaeological analysis of furnace sites with ethnographic data on preferred fuel species among iron smelters, and concluded that tree species were selected that compromised on the burning characteristics of the charcoal produced in order to minimise the depletion of forest resources; a conclusion that counters colonial and post-colonial narratives which argued that indigenous iron smelting was a major contribution to deforestation and hence soil erosion in the area.

At this discourse level, therefore, an archaeological contribution to development might simply involve an awareness of the potential relevance of project data, coupled with an effort to advertise the nature and limitations of this material in a form accessible to a wider audience. Participation at this level need not require an in-depth knowledge of the debates involved, and is simply a recognition that archaeological investigations routinely produce an array of evidence that might be employed to address questions asked from within other disciplines.

Mitchell (2004), for example, has recently called attention to the existence of a range of environmental proxies from archaeological sites in South Africa, some of which can be reliably placed within a sequence extending back 25,000 years. Much of this material remains unanalysed but offers the potential to act as a tool for refining palaeoenvironmental and palaeoclimatological models produced from other sources. Of potentially greater significance, since the data was produced by projects targeted towards the examination of human activities, this environmental archive presents opportunities to investigate how communities respond to, or even influence, environmental change.

This ability to explore social, technical and environmental factors and to place these within a temporal framework would seem to make archaeology ideally suited to the task of identifying sustainable modes of resource use, either through the definition of such systems in the past, or by demonstrating the antiquity of contemporary practices. However, this apparent potential has rarely been translated into high levels of involvement in projects that aim to re-apply elements of such systems. That having been said, despite a long tradition of artefact analysis and of experimental archaeological investigations into tool manufacture, attempts to re-use fixed structural technologies such as irrigation features and field systems have been initiated, whereas archaeological input into the possible re-employment or exportation of portable technologies is virtually unknown. A possible exception, however, is the rediscovery and re-employment of the formerly abandoned Nigerian 'pot-in-pot' food storage ceramics, which preserve food in the central pot through the cooling effect caused by the evaporation of water mixed with sand in the outer vessel (Intermediate Technology Development Group 2003). However, it is difficult to see the minimal archaeological involvement in this project as being pivotal to its success. Similarly, whilst Agbaje-Williams (1996: 806) has suggested that archaeological "research into the resilience of African mud architecture will be rewarding" and could alleviate housing problems by limiting the need for imported cement (an argument similar to that presented earlier by Fathy – 1973 – and developed through the International Institute for Appropriate Technology, Cairo) such work seems unlikely to require a specifically archaeological component.

The possible reasons behind the lack of archaeologically-based contributions to projects that focus on 'low-tech' solutions can be attributed in very general terms to issues of labour investment (whether real or perceived) and to assumptions of obsolescence; both of which include the possibility that technically viable processes might be rendered obsolete within modern market economies. Thus, although the archaeological examination of Late Iron Age iron furnaces in South Africa has demonstrated the existence of an indigenously developed technique capable of smelting ores that would be rejected by modern commercial smelting operations (Killick 2004; see also Schmidt 1995: 138), considerable further research would be required to examine whether this process has the potential to be usefully employed in the future.

A further issue that may act to prejudice the outcome of projects of this sort is that any attempt to export local technologies (whether defined archaeologically or via direct observation) removes them from the precise environment for which they were developed and divorces them from the social structures that produced and/or maintained them. It is perhaps for this reason that the more concerted efforts to re-employ abandoned technologies have done so by renovating structures in situ. Spriggs (1981), for example, describes an attempt to restore and re-use abandoned irrigation channels in the Solomon Islands, whilst Kendall (1997; 2005) outlines the results of a project in highland Peru that sought to re-employ Inca and pre-Inca irrigation canals as a means to supply potable water to rural communities. Both projects also explored the potential of reviving abandoned field systems (pondfields in the Solomons; terraces in Peru) and investigated the possible advantages of these local adaptations via soil analyses (Keeley 1985, and latterly Branch 2003) and through estimations or records of crop yields (Spriggs 1980).

A similar approach was employed by Erikson to study *waru-waru* agriculture in the vicinity of Lake Titicaca, Peru, as part of an archaeological research programme that would later be expanded to become the Proyecto Agrícola de los Campos Elevados or Raised Field Agriculture Project (Erikson 1994, 1998 [1992]). The methodology employed combined the excavation of raised beds and their associated canals, with soil analyses, palaeoenvironmental sampling and an experimental component designed to examine field function, crop yields and labour investment. Starting with five ridges totalling approximately 225 square meters in 1981 (Erikson 1985), by the time of the last season in 1986 the project included the cultivation of communal lands with labour drawn from up to 150 families (Erikson 1994), and had begun to experiment with the cultivation of old as well as new world species, thereby moving beyond the project's original objectives of defining how the system functioned in the past, to assess how raised bed agriculture could be most productively employed in the future. Following the end of the research programme several development agencies supplied support to allow the project's local participants to continue to experiment with the techniques, however, in most cases the reinstated *waru-waru* were abandoned following the removal of so-called pump priming funds (Sillar pers. comm.).

A similar fate befell an attempt to employ raised beds in wetlands near Villahermosa, Mexico in the late 1970s (Denevan 1982; Gómez-Pompa et al. 1982; Erikson 1998), where government support for a project that aimed to cultivate fields inspired by Aztec and Maya *chinampas* was withdrawn following crop failures, escalating costs and local dissatisfaction with the organisation of communal labour (Erikson 1998: 42 citing Chapin 1988). As Erikson notes, however, the project did not include an archaeological component and thus the fields were not closely modelled on abandoned examples. Indeed, it is possible that fairly elementary errors such as re-depositing infertile sub-soils rather than humus-rich lake sediments on the raised beds could have been avoided if designs had closely mirrored those revealed by archaeological sections. However, the project most often cited as an example of the successful application of archaeological techniques to aid in the definition of agricultural development, also acted more as an inspiration than as a direct model to be replicated: thus, although aerial surveys, archaeological planning and excavation were employed to define the agricultural function of cross-wadi terraces, runoff features and runoff collection channels in the Negev, Israel, the resultant agricultural re-use of the area employed water harvesting techniques that were similar to, rather than copies of, their first millennium BC antecedents (Evanari, Shanan and Tadmore 1971; particularly chapters VII and IX). Nevertheless, it is undoubtedly the case that the establishment of an experimental station that included the partial reconstruction of a farm and its associated irrigation and terrace structures near Avdat was instrumental in demonstrating the utility of these techniques and thus the habitability of the area (ibid.; see also Olson 1985: 731-2).

These four examples of the in situ re-use of archaeologically defined agricultural features (Spriggs, Kendall, Erikson, Evenari et al.) have several factors in common. Firstly, all were initiated to address purely archaeological concerns of investigating the nature, date and function of abandoned agricultural features, and only later explored the possibility of their contemporary application. Secondly, although none of the writers/project directors discuss the theoretical positions of their respective projects or the wider theoretical and political implications of involvement with developmental programmes, all four projects are firmly positivist in outlook. Thirdly, and no doubt related to the previous point, all four pre-date the peak of interest in indigenous knowledge projects of the early to mid 1990s (Sillitoe 1998: 224), and none of the writers explicitly discuss indigenous knowledge debates within related disciplines, either at the time when the projects were in operation, or in later retrospectives (for example Erikson 1994, Kendall 2005). Finally, in each of these instances the studied agricultural systems could be described as 'intensive' (though the appropriateness of this term will be discussed in chapter 3) and, with the exception of the Negev project, the decline or abandonment of these systems can be reasonably linked to colonial disruption. These similarities raise issues that may not have been contentious in the context of these earlier projects, but which would need to be addressed by any subsequent attempt to use archaeological techniques to assess the feasibility of re-employing local modes of resource exploitation.

Of these similarities, the issue of abandonment, and in particular the cause of this abandonment, is probably the most significant. The shared experience of working in areas where abandonment can be seen to have been either caused, or exacerbated, by colonial disturbance, means that the projects can start with the premise that the systems under investigation may have been ideally adapted to local environmental conditions; an hypothesis that seems counter-intuitive where abandonment may have been caused by systemic collapse or failure to adapt to changing environmental circumstances. Moreover, since in the Peruvian cases the colonial encounter in question is post-medieval in date, the projects avoid many of the potential political ramifications that might beset similar attempts in areas of more recent colonial expansion. As such, the projects can build on the reasonable assumption that the gradual process of experimentation and refinement that leads to an understanding of how an area can be exploited has already taken place over a far longer period than any contemporary development project could hope to afford.

In this last respect, the projects effectively echo the stance advocated by Bebbington (1997), who argues that rather than using case studies of sustainable strategies to deconstruct environmental orthodoxies (for example Leach and Mearns 1996), such areas should be seen as isolated success stories and studied for that reason. It should to noted, however, that Bebbington is referring to extant communities. The confidence with which Erikson, Evenari et al., Kendall and Spriggs employed archaeological techniques to gain access to these potential paradigms needs to be questioned in detail therefore, as does the issue of whether heritage management policies developed since the 1980s risk limiting the potential of future projects with similar objectives. The extent to which the label 'archaeological remains' effectively limits local ownership by bringing areas within the realm of external specialists, whereas currently employed areas of comparable age are retained locally, also needs to be seriously questioned (Siller 2005: 84). Similarly, the question needs to be asked as to whether the renovation of abandoned features is an act of heritage conservation or an act of destruction (Kendall 2005: 219-20; Siller 2005: 89 and 91).

Although the developmental aspects of these earlier schemes cannot be regarded as unmitigated successes, the projects remain the most complete examples of the in situ re-application of archaeologically defined local knowledge and, as such, are instructive in examining the feasibility of a similar approach elsewhere. However, since these earlier attempts at an applied archaeology started with the premise that long-lived methods of resource exploitation may be better adapted to local conditions than introduced schemes, it is clearly counterintuitive to expect the results achieved in one part of the world to be readily replicated in another. As such, the aim of this study is to explore whether the history of east African agriculture offers insights of value to rural development on the three levels defined above: the questioning of narrative models; the possibility of technology transfer, and the feasibility and desirability of the re-employment of abandoned agricultural features. In short, the project aims to examine what role archaeology can play in the definition of the history of east African agriculture, and will explore whether archaeological methods provide information of sufficient detail to qualify debates regarding the efficacy and sustainability of local agricultural practices.

East African intensive agriculture as a source of indigenous knowledge

> We do not wish to imply that, once the agricultural experts and the relief agencies start talking to archaeologists and comparative linguists and others probing the history of agriculture in Africa, they will correct all shortcomings. [...] But on a more modest plane, the message of recent historical research illustrating the complex and constantly evolving past of African society and culture – and of agriculture which is integral to it – needs to be appreciated if modern programmes of rescue, improvement or genuine development are to be devised with any chance of success.
>
> (Sutton 1989: 1).

The colonial and post-colonial history of Africa is filled with examples of attempts by governments and external agencies to intervene in the management of agriculture and, as such, the history of paradigm shifts between periods of respect for indigenous agricultural techniques and periods in which these same practices have been viewed as inefficient or even destructive, will not be reviewed in detail here. However, for the purposes of this introduction it is worth noting that early European accounts, including those of agronomists and horticulturalists, often expressed admiration for indigenous resource use strategies (Grove 1987, Mackenzie 1998), and despite perhaps predictable colonial accounts that denigrated local practices in order to justify the appropriation of resources, there are nevertheless well documented examples of attempts by colonial governments to learn from local techniques. Probably the most often cited example of this approach is Richards' (1985) study of agricultural policy in British West Africa during the 1930s and 1940s, which illustrates how indigenous techniques that countered soil erosion were seriously explored following the 'dust bowl' environmental crisis in the USA in the 1930s; a theme that had previously been addressed by Anderson's study of agricultural narratives in Kenya, Tanganyika and Uganda during the same period (Anderson 1984). However, even in an area where government officials had spoken favourably of indigenous practice such as in Marakwet, Kenya, interventionist policies were enacted from the 1940s onwards that sought to improve and rationalise the local techniques (Adams 1996; Kipkorir 1883; Soper 1983; Watson, Adams and

Mutiso 1998). Despite the value placed on indigenous anti-erosion measures elsewhere in the region, the pretext for this intervention was frequently on the basis that the system led to loss of soils from the valley sides. Moreover, it is significant from the perspective of the current study that in the case of Marakwet, the assumed antiquity of the system was also used to justify European involvement on the grounds that its current users were argued to be pushing the system beyond the limits of an ancient design (Adams 1996).

In retrospect, the failure of many colonial period interventionist programmes that aimed to introduce or adapt technologies such as irrigation or terraces has been blamed on an inability on the part of external authorities to foresee how these introductions would be perceived locally (for example Feierman 1990; Maack 1996; Moore 1983; Tiffen et al. 1994), though purely economic arguments have also been presented (Iliffe 1979). Whilst the same charges can also be levelled at post-independence modernisation schemes, criticism of more recent development programmes has tended to focus on inaccuracies in the models upon which such interventions are based; on detrimental environmental effects of large scale projects (for example Adams 1992, Adams and Grove 1984); and on the short-term aims of crisis-led relief operations. Cutting across all of these concerns is the recognition of the potential political effects of external intercession and, in particular, distrust of the concept that benefits will 'trickle down' through all levels of society when in reality any intervention risks inadvertently prioritising, or even creating, local elites. From the early 1980s onwards, therefore, an attempt has been made to address these concerns through the concept of 'development from below' (Stöhr and Taylor 1981); a strategy that aims to emphasise small-scale, locally managed, often rural projects that employ 'appropriate' or 'indigenous' technologies. At a rhetorical level at least, this concept has found support within international organisations including the World Bank (Mackenzie 1992) and the United Nations, and indeed many of the principles of development from below are emphasised by Agenda 21 (UN 1992).

Within east Africa the interest of external agencies has frequently been focussed on a fairly limited set of communities whose population densities and level of labour investment in landscape modification exists in marked contrast to the expansive pastoralism that is often viewed as characteristic of the region. Recently referred to as 'islands of intensive agriculture' (Widgren 1999, 2000 and Widgren and Sutton 2004), these systems employ structural features such as terraces and irrigation furrows that should be readily susceptible to archaeological investigation, and thus would appear to offer opportunities for an archaeological contribution to these developmental debates. Irrigation features have been constructed in the areas of Marakwet and Pokot in Kenya; at Konso in Ethiopia and at Sonjo, Pare, Meru, Usambara and Kilmanjaro in Tanzania. Agricultural terraces exist at Harar and Konso in Ethiopia; in the

South Pare Hills and at Ukara Island in Tanzania, and at Nyanga in Zimbabwe. Both terraces and irrigation structures were formerly employed at Engaruka, Tanzania, although the site has since been abandoned. The hypothesis to be tested here, therefore, is whether the archaeological examination of these systems can generate insights of value to developmental research.

That these systems should have excited the interest of researchers, governments and development agencies is unsurprising: in terms of scale, many of the east African 'islands' of intensive agriculture are undoubtedly impressive (the main furrows at Marakwet total roughly 250 km in length with the longest running for approximately 14km, whilst the irrigated field system at Engaruka covers roughly 2000ha), yet the communities that built and maintain(ed) these systems did not require the central control of labour as predicted by Wittfogel (1957), and manage to continue to farm areas despite the predictions of resource depletion made by external specialists (Carswell 2002). As a group, therefore, they appear to fit within the tenets of Agenda 21 as regards low external input, locally managed, sustainable agriculture, with the added advantage that most of these areas support contemporary conservationist ideas regarding the desirability of 'zero' tillage systems (Evans 1998). In short, these communities are seen as potentially paradigmatic in terms of their ability to sustain relatively high population densities whilst retaining the flexibility to cope with unanticipated change as evidenced by their apparent 'resistance' to colonial intervention. However, in the absence of an in-depth understanding of the long-term histories of these systems, it is difficult to assess the accuracy of this appraisal.

The discussion that follows, therefore, includes a review of the published literature pertaining to these systems and to other agricultural economies that may act as analogies or contrasts, with a view to questioning whether the available contemporary and historical data supports the assumptions and conclusions of the proponents of indigenous knowledge based development. Thereafter the results of the fieldwork undertaken at Engaruka are presented in order to question the potential archaeological contribution to this area of study, either as a means to qualify historical assumptions, or as a method of directly examining the function of indigenously developed technologies. As a comparatively well preserved abandoned agronomy that formerly employed very visible agricultural features in the form of terraces and irrigation channels, Engaruka offers opportunities to examine the development of agricultural structures and the consequences of their cultivation in an area that has not been disturbed by subsequent exploitation. However, the study of an abandoned agronomy also highlights the limitations of archaeological knowledge in terms of the reconstruction of the social structures and management techniques that do not leave clear or unambiguous evidence in the archaeological record.

Before examining examples of African indigenous agricultural knowledge, therefore, it is necessary to examine what is meant by 'indigenous knowledge' and 'archaeological knowledge' and to examine the relationship between them. This discussion forms the next chapter, and serves to emphasise that there are clear theoretical, and indeed political, implications involved in any attempt to employ a discipline designed to elucidate events in the past as a means to assessing the viability of policies in the present. It is perhaps worth reiterating, therefore, that the realignment of perspective endorsed here relates to outcomes and intended audience. This means that the current project makes no claims to being a developmental study. It remains simply an archaeological study that attempts to address archaeological questions, but these are questions that have been posed (whether intentionally or unintentionally) by developmental debates.

2

Historical, archaeological and indigenous knowledge

> A prominent paradox in African historical studies is that archaeology's potential for developing alternative histories has not been fully realized. Because most of ancient African history is accessible only through archaeological approaches, there is compelling reason to refocus attention on archaeological constructions of the past as a means to build an independent, authentic and distinctly African history. At the same time, archaeology is a distinctly Western activity. Its governing paradigms and epistemologies often conflict with African historical needs, views of the past, and ways of structuring time and space. Thus the paradox unfolds: a repertoire of techniques and approaches that promise significant ways of recuperating African pasts heretofore obscured is accompanied by theoretical assumptions that are often out of tune with African sensibilities, needs, and structures.
>
> (Schmidt 1995: 119)

> Only by digging into the conceptualizations of rural and urban African societies, especially as expressed in ethnographic and oral historical sources, can we gain entry into the fabric of African knowledge systems. [...]. Understanding those knowledge systems is a firm basis for learning the social and environmental plans and designs of past populations and for formulating actions for social and environmental planning today.
>
> (Andah 1995a: 173)

The two statements above originated from a seminar that aimed to explore issues arising from the use of the essentially western disciplines of archaeology and historiography in non-western settings (Schmidt and Patterson 1995). In summing-up the discussions at this seminar, Wylie (1995: 267) reports that the participants issued a series of recommendations which included an "insistence" that those engaged in historical research should prioritise questions that are "relevant" to local communities, and should thus be carried out "for the people". In Andah's terms, African archaeology should be striving to produce a "usable past", defined as a past "that does not merely instil pride" but which also helps "fight 'cultural poverty' and negotiate justice at both national and international levels" (Andah 1995a: 151). In questioning how this objective might be achieved, both Schmidt and Andah raise theoretical and methodological issues of direct relevance to the current study. Both are concerned by the denigration of the African past which they see as partly the result of an assumption that archaeological and oral historical sources are less reliable than documentary evidence, thereby placing an undue emphasis on the more recent (colonial and post-colonial) periods. This contraction of the African past, they argue, tends to downplay local innovation and thus reinforces the stereotype that African societies are static. By offering a far greater time depth, it is asserted, an African archaeology informed by oral history can "create new and socially responsible knowledge unconfined by the colonial library" (Schmidt 1995: 136), and in so doing can challenge these received notions. Moreover, through an ability to explore evidence of technological change directly, archaeological research is able to investigate technical aspects of African knowledge, for which Schmidt presents an example from his own work that helped define unique preheating techniques used by precolonial iron smelters in the Usambara mountains of Tanzania (Schmidt 1995: 138), whilst Andah (1995a: 165) states, without going into details, that "the drought phenomenon in the Sahel [...] either would not exist or would not be so severe if the time-honoured conservation programs of local people had been treated with more respect by the 'advanced' technological powers". The hypothesis to be examined here – that archaeological techniques can aid in development planning decisions by placing indigenous resource use strategies in their historical context – is therefore endorsed by both writers, though both stop short of suggesting that archaeological sites might act as direct paradigms for developmental programmes.

However, contrary to the impression given by the two quotations that head this chapter, Andah and Schmidt fail to fully explore what they mean by "African knowledge systems" or African "ways of structuring time and space", and ultimately opt for the approach of employing conventional archaeological techniques to question entrenched assumptions about African societies. Similarly, they restrict their theoretical discussions to more pragmatic concerns such as problems of funding, and to the colonial and nationalist legacies which they see as manifesting themselves in African, European and north American universities and research institutions. They are therefore primarily concerned with the politics of representation and, as such, the histories they advocate are 'corrective' rather than 'alternative'. Indeed, despite Schmidt's (1995: 120) claim that "my approach emphasizes the importance of African contexts and distinctive values of time and space in negotiating interpretations of the African past", no attempt is made to address the dilemma of potential epistemological conflicts that he himself raises, beyond a brief and inconclusive discussion of Andah's earlier position (Schmidt 1995: 145 citing Andah 1987). Within this discussion it is noted that "some will argue" that Andah's call for the incorporation of an African epistemology into African archaeology risks falsely homogenising a rich diversity of belief systems (for example Holl 1995: 226 in the same volume; though note too that Andah refers to knowledge *systems* in 1995), but thereafter problems of reconciling different approaches to fundamental criteria such as causation or the nature of time are not discussed. The question of how these local systems of knowledge construction will be recognised is thus not addressed, and neither is it explicitly acknowledged that these modern African epistemologies need not be shared by communities in the past (Stahl 2001: 222).

Nevertheless, as the above quotations make clear, both writers clearly recognise the importance of seeing local technical innovation (and the history of this innovation) as originating from within frameworks provided by indigenous epistemologies, and both express confidence that historical techniques can gain access to these categories of thought. From this standpoint it is reasonable to assert that historical research of this kind will have practical applications in the future. The aim of this chapter is to question the validity of this conclusion by presenting a more thorough examination of the issues raised above. In short: what is meant or implied by the concepts of 'African knowledge systems', 'indigenous knowledge' and 'historical knowledge'; what is the relationship between them, and can historical/archaeological knowledge reasonably claim to be a route to developmentally applicable indigenous knowledge?

What is historical knowledge?

> Historical thought is always of the past, of something which can never be to the historian a this, because it is never here and now. The events which he studies are events no longer happening, the conditions he describes are conditions no longer in existence. History is a standing refutation of all theories which describe knowledge as the apprehension of an object which, to be apprehended, must exist, or think of subject and object as somehow compresent in one environment.
>
> (Collingwood 1999 [1935]: 168-9)

Rather than Childe's 'bombs and butter', the only thing archaeology and historiography produce directly is historical knowledge, or, to put it another way, they produce knowledge about the past. As has already been noted, this information is potentially of great significance in terms of the promotion of indigenous modes of resource exploitation, since it offers the ability to place this knowledge in its historical context and thus to act as a qualifier in arguments that espouse either introduced technologies or local adaptations. Without this information it is extremely difficult to make reliable assessments of the sustainability of a given strategy of resource use. However, to say that historical knowledge has something unique to offer prompts the question: is their something unique about historical knowledge itself? The sub-question to this enquiry: is there something unique about archaeological knowledge, will be returned to below. For the moment it is sufficient to treat historiography and archaeology as two aspects of historical research, even though they have their own strengths and weaknesses in the context of the current study. They can be treated together because both disciplines share the primary aim of attempting to elucidate the nature of events in the past, and both face the problem that, in terms of the western conception of linear time at least, "The past does not exist" (Reid and Lane 2004:1).

The question of the nature of historical knowledge has been explored in detail by Collingwood (1999, 1940 and 1946), who tackles the issue by first examining the problems with what he terms the 'common-sense' theory of historical knowledge. According to this conception, the role of the historian is simply to collate the memories of individuals who are in some way acquainted with the events the historian wishes to explore. This simplistic approach is rejected on the grounds that it elevates all sources to the status of objective authorities; it ignores the problem that the historian may need to select only elements of the available sources; it assumes that contradiction between sources will be limited, and it does not allow for the contribution of non-linguistic (archaeological) sources of evidence. Thus, under this conception it would be impossible for the historian to discover anything that had not been known previously by those involved in the production of the source material. However, the critical examination of historical evidence clearly can produce information that was unknown at the time this evidence was generated. For example, any given individual involved in the production and distribution of a particular commodity need have no idea of how widely this product is distributed (or are alienated from their market in Marxist terms). The historian examining this question may, therefore, be the first person to ever gain this knowledge. This ability has an obvious relevance to the current study since it allows for the possibility that those involved in a particular resource exploitation strategy may themselves be unaware of the reasons why their economy either flourished or failed. However, the rejection of the common-sense view of historical knowledge, and the realisation that the historian is producing original ideas about past events, also highlights the extent to which the process of writing history is always an act of interpretation, and hence that historical narratives are constructions rooted in the present, rather than objective reconstructions of the past.

To say that historical knowledge is always a subjective interpretation is, of course, neither new nor controversial (see, for example Carr's 1913 discussion of Croce). However, the term 'interpretation' encompasses a series of critical assessments that need to be defined. Collingwood's (1999 and 1946) approach to this issue is to note that any attempt to produce what he calls a 'critical history' requires a 'constructive history'. To re-use the metaphor Collingwood himself employs, a critical history involves the interrogation of sources as if these were court witnesses or, in the case of archaeological data, as if these were material evidence. Thus, the questions asked of these sources include enquiries such as: where and under what circumstances was this evidence found; how does this relate to other material evidence and to the testimony of witnesses; how do the witnesses know what they claim to know; what details are omitted from the testimonies or material evidence, and how, and for what reasons, might the witnesses be biased. In short, the role of the court and the historian is to reach a reasonable conclusion as to the nature of a particular event based on the evidence available at the time of the enquiry. In both examples, the decision (itself a metaphor with interesting connotations in terms of the current discussion) is arrived at by bringing together and comparing sources for what may be the first time. In doing so the intention is to achieve an understanding of the event that surpasses that of any individual witness or, alternatively, to collate a body of evidence that can act as a substitute for a direct observer of the event in question. The aim of the historian is to place him or herself in the position of this observer, and it is at this level that Collingwood regards historical knowledge to be 'constructive' (for example 1999: 150), because such a process requires interpolative or extrapolative inferences that are based not on the experiences of the sources, but on the experience of the historian.

To push the legal metaphor slightly further than Collingwood, both the court and historian might find themselves asking two distinct questions: what do the protagonists and witnesses think happened, and what 'actually' occurred. Taken together, these two questions acknowledge that the combined testimonies are likely to offer an incomplete picture, and that the witnesses may have forgotten, not observed, or be deliberately withholding, details of the events under examination. In short, the witnesses are subject to a range of conscious, unconscious and observational biases, with the consequence that the task of explaining or understanding events in the past can never be reduced to a simple statistical examination of the 'balance of opinion'. From an historiographical perspective this would merely be a descriptive history which might take the form: 'at the time most people attributed event A to reason B, though some thought it resulted from C'. To ask which of these views is correct, or to acknowledge that they may all be 'mistaken' in their interpretation of events, is to engage in a quite different form of enquiry that necessitates the incorporation of categories of evidence that are distinct from witness testimonies. To put that another way: to accept that sources are subject to critical examination, be that an appraisal of whether a statement is 'true' or an assessment of the validity of archaeological data, is to acknowledge that the historian is bringing something to the inquiry that is not inherent in the sources themselves. The historian is not looking for a quality within these sources – truth/fact – but is attributing this property to them. The question therefore becomes: what is the criterion employed to attribute this status? The shorthand response to this question is to employ one of a series of synonyms to ask whether the sources are reliable; dependable; trustworthy, and to question whether the picture presented by them is plausible; reasonable; believable; credible; probable. Although this is doubtless a fair summary of what the historian is doing, it is an insufficient answer because it ignores the problem that plausibility is contextually specific: individuals or groups may employ different criteria of plausibility in different circumstances, and what is considered plausible is directly related to culturally and contextually specific notions of causation.

Thus Collingwood (1940: 285, 287) identifies three senses of the word 'cause' in English that are potentially mutually incompatible. The first of these is the historical sense (referred to below as sense I) which implies an event which provides an individual with the motive for a resultant action. The second sense is that in which an individual agent applies perceivable natural laws to bring about an event (sense II). Finally, there is the essentially 'pure' physical causational effect that need not require human agency or observation (sense III). To take an example from one of the communities to be discussed below, farmers from Shambaa, Tanzania, maintain that certain individuals are capable of inducing rainfall and were therefore paid tribute for this service (Feierman 1990: particularly chapters 2 and 3). The local conception of rainfall therefore involves Collingwood's sense II (an individual manipulates the environment to bring rain), whereas an historian with a grounding in western science is likely to treat rainfall in terms of sense III (as a natural phenomena), and human reactions to it via reference to sense I (in this case, perhaps, that the need for rain provided a motive for some individuals to supply that need, whilst others were given a powerful reason for paying for that service). In attempting to produce a plausible historical narrative, therefore, the historian may be obliged to reject the notion that an individual in Shambaa society could affect the weather, on the grounds that his or her own conception of the way in which the physical world operates contains no mechanism by which this manipulation could occur. Knowing – on the basis of meticulously recorded metrological records and complex computer models – that rainfall in the east African Rift is part of a much wider monsoon weather system, would, however, be of comparatively little worth in explaining how individuals in Shambaa society might respond to, say, a prolonged period of drought.

Nevertheless, in the production of constructive histories the historian's view of causation still predominates; there is still a "hierarchical relationship between the super-ordinate science A [the western empirical 'scientific' view of causation] and the sub-ordinate sciences B [historiography] and C [the Shambaa view of causation]" (Collingwood 1940: 12). An example of this relationship is offered by Keesing (1990) who discusses an attempt by the Kwaio Fadanga of the Solomon Islands to claim compensation for damages sustained as a result of a punitive expedition that followed the assassination of a British District Officer in 1927. The claim included a demand for reparations for the lives and property lost at the time of the assault, as well as for the subsequent deaths of individuals killed by ancestral spirits whose shrines had been desecrated; an assertion that is given added veracity since these acts of desecration were probably perpetrated by local police who were well aware that damaging the shrines would anger Kwaio ancestors (Keesing 1990: 293). These two views of the past are obviously incommensurate given that local and international law do not recognise the existence of a mechanism by which these ancestors could have vented their anger, whereas to the Kwaio this mechanism is only too real. As much as the historian needs access to the local conception of causation to explain the historical background to events like the Kwaio claim, (s)he nevertheless falls back on the dominant (and hegemonic) 'scientific' conception of causation in order to produce a single narrative that can account for all sources of data, and is arguably obliged to do so on the grounds that any claim to historical authority rests on an empirical foundation. Or rather, historiographical claims to authority are founded on the discipline's apparent ability to draw together what are potentially two competing claims to knowledge in the form of empirical science on the one hand, and the collation of testimonies on the other (see figure 2.1 below). Yet because historiography and archaeology both employ scientific notions of causation, the historian is obliged to prioritise the former, and thus as the two examples above make clear, statements that are incommensurate with the historians conception of reality have to be treated merely as contextual information, rather than as factual statements pertaining to past events.

When Schmidt (1995: 120) talks of "negotiating interpretations of the African past", therefore, it is not clear on whose terms, or on what common ground, he feels this negotiation will take place. Note, for example, that although Appadurai (1981: 1) argues for "the existence of culturally variable sets of norms whose function it is to regulate the inherent debatability of the past", these norms inevitably rely on local conceptions of time and causations and are thus likely to produce conflicting images of history that limit the scope of any cross-cultural negotiation as to the nature of past events. How, for example, would this negotiation process treat conceptions of history that rely on direct contact with ancestors, for which the Shona medium cults in Zimbabwe might serve as an example (Bourdillan 1978)? This is not to say, however, that historical knowledge is capable of disproving these conceptions, since it is clearly impossible to empirically demonstrate non-existence. Moreover, since claims to historical knowledge rest on their coherence and consistency in relation to both evidence and to the historian's conceptions of causation, equally consistent interpretations that rely on alternative conceptions cannot be historiographically or archaeologically invalidated.

In Collingwood's (1940; particularly chapter IV) analysis, it is thus entirely possible for conflicting images of the past to be equally correct in the sense that both can be thought of as a chain of questions and answers (or relative presuppositions) that are ultimately based on an absolute presupposition; i.e. those suppositions that always stand in relation to other presuppositions as questions, never as answers, and which are not questioned because they are not verifiable. These root presuppositions upon which enquiring argumentation is ultimately based, could be variously 'revelation X presents divine truth' or 'everything that occurs has an empirically observable physical cause'. It follows from this that to treat absolute presuppositions as if they can be invalidated by recourse to truth-value constitutes what Collingwood terms "pseudo-metaphysics":

> This will be a kind of thought in which questions are asked about what are in fact absolute pre-suppositions, but arising from the erroneous belief that they are relative presuppositions, and therefore, in their capacity as propositions, susceptible of truth or falsehood. Pseudo-metaphysics will ask of such questions as this, where AP stands for an absolute pre-supposition: Is AP true? Upon which evidence is AP accepted? How can we demonstrate AP? What right have we to presuppose it if we can't?
>
> Answers to questions like these are neither metaphysical truths nor metaphysical errors. They are nonsense.
>
> (Collingwood 1940: 47-8)

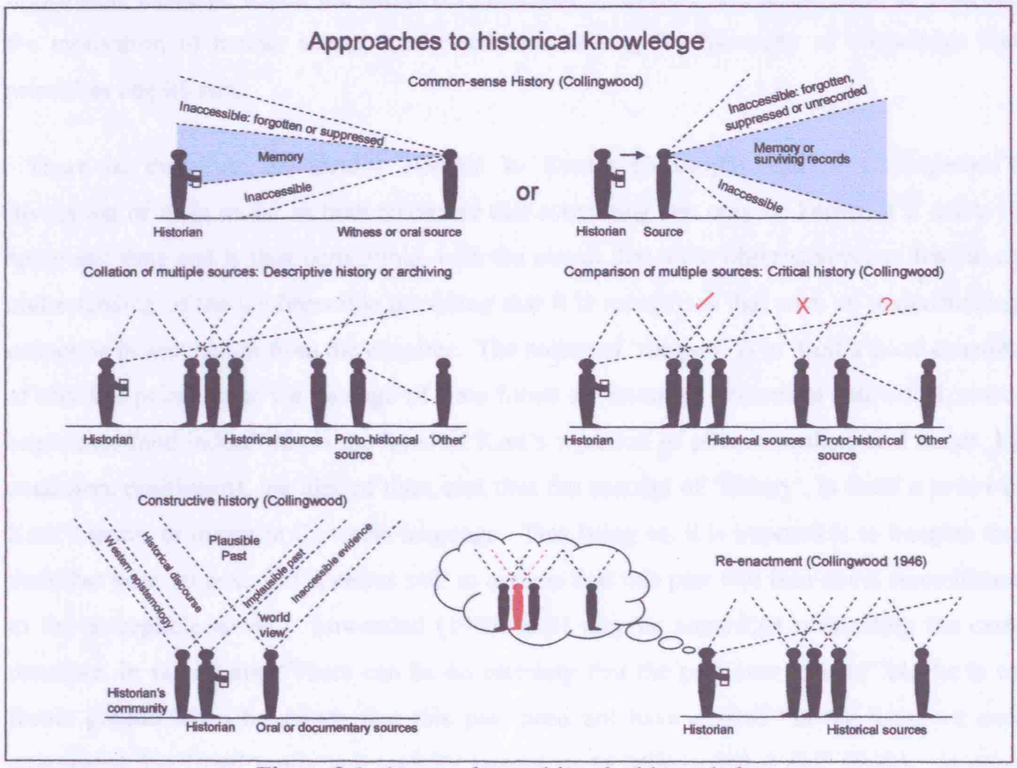

Figure 2.1: Approaches to historical knowledge

As should now be clear, the relationship between empiricism and historical knowledge is not direct, but the concept of observation is always invoked, albeit generally through the vague notion of plausibility. Following Kant, Collingwood characterises historical knowledge as *a priori*, by which it is not meant that claims about the past are simply produced deductively, but rather that the non-existence of the past means that it cannot be directly experienced by the historian, and thus any image of it cannot be properly considered to be empirical. However, this distinction between *a priori* (or transcendental) and empirical examinations of the validity of concepts is fragile because, as noted, perceived empirical information from the historian's own experiences, together with the collective experiences of the wider community, informs the assessment of what is plausible. This interconnectedness of *a priori* and empirical knowledge is recognised, and indeed highlighted, by Kant (1993 [1781]), who is emphatic that knowledge can only be achieved by observation and experience. What transcendental enquiries allow, in contrast, is the ability to conduct investigations into unobserved or unobservable events by asking the question: under what conditions could such an event be experienced? It is thus in this sense that Collingwood uses the term *a priori* in reference to historical knowledge and, moreover, it is the reason why Collingwood repeatedly emphasises that historical knowledge is an act of empathetic imagination. This process of empathy, termed re-enactment by Collingwood (1946), allows the historian to take account of implausible elements within the narratives presented by sources and to use these to establish the motivation of human actors, whilst still maintaining the hierarchy of knowledge that prioritises empiricism.

There is, therefore, an idealist element to Kant's philosophy and in Collingwood's invocation of it, in so far as both recognise that something can only be known if it exists in space and time and is thus perceptible, with the caveat that these observations can lead to an understanding of the unobservable providing that it is recognised that such an understanding cannot be in abstraction from the enquirer. The notion of 'the past' is in itself a good example of this last point: since the passage of time forms an essential element of individual sense-experience (and indeed this is the basis of Kant's rejection of phenomenalism and hence, by extension, positivism), the idea of time, and thus the concept of 'history', is itself *a priori* in Kant's terms, or innate in Cartesian language. This being so, it is impossible to imagine that there has been no past, and it seems safe to assume that this past will bear some resemblance to the perceptible world[3]. Lowenthal (1985: xxii) may be somewhat overstating the case, therefore, in saying that "There can be no certainty that the past ever existed" but he is on firmer ground when he asserts that this past need not have existed "in the form we now conceive it, but [that] sanity and security require us to believe that it did" (ibid.). In other words, since our conceptions of the past are projections of a perceived reality, differences in how that reality is perceived will lead to images of history that diverge from those produced historiographically or archaeologically. Thus historiography and archaeology never produce an 'indigenous past', merely a 'past of the indigenous'.

[3] This assumption may, of course, be over-ruled by historical narratives which maintain that the world in the past was radically different from that now experienced, but unless such narratives are to be consciously read as myths, allegories or parables, they must still be plausible. In such circumstances the burden of credibility falls on the source, not on the narrative

Historical versus 'scientific' knowledge

> [...] the historian's experience of the world in which he lives can only help to check the statements of his authorities in so far as these statements are concerned not with history, but with nature, which has no history. The laws of nature have always been the same, and what is against nature now has always been against nature; but the historical as distinct from natural conditions of man's life differ so much at different times that no argument from analogy will hold.
>
> (Collingwood 1999: 160)

The empirical/*a priori* opposition between knowledge derived from observation and knowledge based on imagining observation appears, superficially, to readily equate with the oppositions between objective and subjective or absolute and relative knowledge with, in each case, the former being characteristic of 'natural' science whilst the latter describe historical conceptions. Indeed, under such a categorisation historical knowledge could be argued to be unique even among the social sciences since it alone may be produced without any interaction with the communities it seeks to understand. As will be returned to below, this argument has been extended to suggest that archaeology is somehow more objective than historiography on the grounds that archaeology prioritises the empirical observation and measurement of physical indices of the past, and that this evidence is not subject to the same degree of human manipulation, bias and reinterpretation as either documentary or oral sources. Although this view is often seen as being associated with so-called 'new' or 'processual' archaeology (for example Binford 1977; Bintliff 1991), it also resurfaces in the later work of the authors of the 'post-processual' critique (for example Shanks and Hodder 1996, see below). Thus, whilst historiography merely approximates an objective, empirical science by replacing repeatable experiments with details of its source material and by explicitly outlining its biases (at least in theory), archaeology appears to offer a form of experimental objectivity that, if not always repeatable, does at least avoid the need to assess the subjective biases of its sources. Thus archaeology forces an examination of the simple equation of history : science = subjective : objective.

In discussing this issue, Wylie (1993: 21) cites Kluckhohn's (1940) statement that "no fact has meaning except in the context of a conceptual scheme" and Steward's (1944) assessment that "facts are totally without significance and may even be said not to exist without reference to theory", to argue that archaeology does not circumvent the issue of historical subjectivity, and to illustrate that problems with the simple subject : object opposition were well understood prior to more recent attacks on claims to objectivity delivered via related postmodern and poststructural debates. It should be clear from the discussion in the previous section that Collingwood reached congruent conclusions, and indeed pre-empted the supposedly post-modern stance of highlighting the logical fallacy of attempting to question or dismiss the metaphysical foundations of knowledge claims on rational or empirical grounds. Nevertheless, the more recent and sustained attack on scientific objectivity within the social sciences owes more to Kuhn (1970) and Feyerabend (1975), with the former arguably particularly attractive to archaeologists (Knapp 1996; Wylie 1993) and historians since he presents an essentially historical critique of empirical science which challenges the notion that knowledge gradually 'progresses' through the assimilation of data, by noting that this process is constrained by sets of theoretical presuppositions (paradigms) which are only dropped when the case against them becomes overwhelming.

Employing the analogy of political revolutions, Kuhn notes that paradigm shifts are characterised by a sub-section of a community expressing dissatisfaction with the ability of existing frameworks to cope with contemporary problems, whilst the proponents of these established institutions often entrench their position in defence. Pushing this analogy further, it is argued that revolutions are more likely to occur when there is an ideological impasse, or when the reformist movement seeks to change institutions in ways prohibited by these institutions themselves. Correspondingly, debates surrounding paradigm shifts arise precisely because an anomaly is identified that cannot be accounted for by the existing paradigm, but which could be accommodated by an alternative theory. The two theories must, therefore, be logically incompatible and thus proponents of either are likely to enter into circular arguments that defend their respective paradigm in its own terms. Moreover, since the two paradigms are likely to address different problems, the criteria for choosing between them may involve value judgements as to which problem, rather than which solution, is the most significant. As value judgements, this decision is necessarily a subjective assessment as opposed to a logical or empirical argument. Empirical science, or at least the practice of empirical science, starts to look much like the practice of history: it becomes impossible to talk of the validity or non-validity of a scientific conclusion without reference to the presuppositions, and hence the contextual biases, under which any given enquiry was carried out (Kuhn 1970: 269).

Feyerabend's (1975) case covers much of the same ground, arguing that various scientific revolutions were not achieved through the rigorous application of objective scientific methods, and that this realisation supports the view that these methods actually restrict the accumulation of knowledge since 'facts' are too weak to force an acceptance of a particular theory, whilst logic is too 'narrow' to accommodate all the available data (Feyerabend 1975: 303). Like Kuhn, he rejects the idea that the practice of science is characterised by an essential openness to newly identified phenomena, arguing that the history of science reveals that the 'scientific community' treats anomalies with suspicion, and that any attempts to question accepted paradigms are regarded as heretical. However, this claim to authority is not built on ownership of data, but on ownership of the method, which is treated not as a route to truth, but as a truth in itself; not simply as a method of explaining nature, but as something that is itself natural. There is thus a clear parallel with Durkheim's (1961) observation of how large institutions come to be so embedded within societies that they appear to be part of the natural order, of which perhaps the most obvious example is the manner in which the 'free market' is regarded as somehow autonomous of the decisions that drive it: 'the market will decide' (Polanyi 1968). By denigrating other forms of knowledge as somehow less natural, therefore, the scientific community aggressively protects its privileged position within societies, and indeed it is considered significant that this position was in the process of being consolidated at the time of European colonial expansion. To Feyerabend, then, the practice of science is not simply unable to escape subjectivity, but its practitioners are beset by what is essentially a deep-seated, if potentially unconscious, bias.

This stance is described by Feyerabend as 'anarchism' rather than as relativism, and indeed his famous formula "anything goes" is a recommendation that scientists should not restrict their methodology or temper hypotheses, rather than an expression of a belief that all interpretations are equally valid (see also Feyerabend 1993). Thus, for the main part Feyerabend, like Kuhn, is not denying the possibility of the advancement of knowledge, he is simply arguing that subjective elements exist within even the most systematic scientific enquiry. At this level the thesis echoes arguments presented by broadly contemporary writers such as Derrida's (1982a [1972]) notion that western thought represents a 'white mythology' through which a local theory of knowledge is presented as universal, or Foucault's (1974) conclusion that this local knowledge is inalienable from the political interests it serves. Said's (1978) discussion of how non-western (specifically Middle-Eastern) achievements have been either denigrated or appropriated serves as a further example, and addresses similar concerns to those raised later by Mudimbe (1988) in reference to Africa.

Such conclusions have a clear bearing on the current study since they highlight the extent to which archaeology has directly or indirectly played a role in the denigration of African history (for discussions of specific instances see Garlake 1973; Kuklick 1991; various contributors to Robertshaw 1990; Rowlands 1989; Trigger 1996) and, moreover, demonstrate the unavoidably political nature of any attempt to consciously employ archaeology to redress this imbalance (for example Andah 1995b; Miller, Rowlands and Tilley 1989; Wylie 1995a; for a more general, non-archaeological discussion see Spivak 1988). However, there is also an anti-foundational element to the critique of claims to objectivity presented by these various writers which goes beyond simply acknowledging that representations are always subjective and inseparable from value-laden theoretical frameworks, and thus suggests a level of relativism with which archaeologists have traditionally been uncomfortable (see below).

Although Kuhn, like Feyerabend, has been frequently characterised as a relativist, he attempted to counter this 'accusation' by arguing that this impression may have arisen from his suggestion that proponents of incommensurable paradigms could be likened to two communities from different linguistic and cultural backgrounds (Kuhn 1970: 205). Conceding that in the case of these hypothetical cultures "both groups may be right" and thus that "Applied to culture and its development that position is relativistic" (ibid.), Kuhn nevertheless argues that the same cannot be said of conflicting scientific paradigms because the history of science illustrates that later theories or technical solutions are more effective than earlier ones. Kuhn accepts, however, that this is a partial answer because it removes any concept of "truth" (or ontological 'correctness') from the judgement of a paradigm's success. That is to say, the criterion of success is no longer based on a claim that each new paradigm is a more complete or accurate reflection of nature or of some other object of study, and instead paradigms are judged simply in reference to whether they are pragmatically useful. In the quotation that heads the current essay, Childe (1956: 127) offers a similar conclusion, albeit without this severing of the relationship between "practical results" and "truth". Nevertheless, Childe's conclusion echoes that of Kuhn in as much as both suggest that the successful application of a discovery can function as, in Childe's words, "the proof that it is a contribution to knowledge and not just a new superstition" (ibid.). It is by no means clear, however, how the criterion of usefulness can be easily applied to claims of historical knowledge, especially given that the issue of incommensurability raises the questions: useful for what; useful to whom, and useful on whose terms?

These questions will be addressed below specifically in reference to archaeology since, as has already been noted, various archaeologists have attempted to claim that the discipline retains a degree of objectivity not enjoyed by historiography, yet archaeologists face the problem that their own presuppositions may lead them to produce interpretations of history that not only conflict with those produced by contemporary communities, but which also include conceptions of time or causation that may not be shared by the societies in the past that form archaeology's object of study. As such, analogies with the physical world, or recourse to scientific conclusions as to nature of the physical world, become problematic. This is not just because of the lack of objectivity within the natural sciences as exposed by Kuhn (1970) and Feyerabend (1975), nor is it simply a result of the context-dependent nature of meaning as discussed by Derrida (for example 1982), though such conclusions are clearly extremely significant. Instead, the primary problem arises from epistemological incommensurability and, put simply, because there is little comfort in 'knowing' that a given phenomenon is physically impossible if the community under investigation took a view to the contrary, as this belief will inform their response to certain situations. This problem is, of course, shared by historiography (see Collingwood 1999: 160 above), but is arguably more acute for archaeology owing to the frequent lack of access to data sources that would allow an appraisal of local conceptions. Contrary to the view expressed by Andah (1995a: 167 and 173), therefore, a reliance on analogies with contemporary communities is potentially just as problematic as a recourse to nature. In short, if archaeology cannot 'see' indigenous knowledge, it will clearly have difficulties in contributing to debates that argue either for or against the prioritisation of developmental paradigms based around local approaches to resource-use.

What is indigenous knowledge

> If ethnography produces cultural interpretations through intense research experiences, how is unruly experience transformed into an authoritative written account? How, precisely, is a garrulous, overdetermined cross-cultural encounter shot through with power relations and personal cross-purposes circumscribed as an adequate version of a more or less discrete "other world" composed by an individual author?
>
> (Clifford 1988: 25)

> In fact the sociologist and his "object" form a couple where each one is to be interpreted through the other, and where the *relationship* must itself be deciphered as a historical moment.
>
> (Sartre, cited in Clifford 1988: 55)

The term 'indigenous knowledge' is clearly somewhat ambiguous, but can be thought of as having two distinct, though obviously related meanings. The first of these is literal and refers to local conceptions of how the world operates and how it can be manipulated, and thus includes both the practical solutions employed by communities to tackle everyday problems, and the theoretical frameworks via which these solutions are produced and understood. The second, in contrast, refers to the suggested paradigm within developmental debates that regards these local technical or management solutions as potential models for current and future strategies of resource use. At the risk of over simplification, the first is the traditional subject for ethnography which, although based or direct observation, produces knowledge that is very much akin to historical knowledge in that it is temporally and spatially situated, and can be regarded as descriptive, explanatory or interpretative. In contrast, the primary concern of attempts to apply locally produced knowledge is simply the technical efficacy of local solutions to given problems: do they work; how do they work? If ethnographic knowledge is composed of the description, explanation or interpretation of indigenous institutions, therefore, then 'indigenous knowledge' emphasises their function. These two approaches thus have different criteria for judging the success of the models they produce. However, in keeping with the archaeological perspective of the current study, it is not the intention here to review in any great detail the various approaches to ethnographic knowledge presented within social or cultural anthropology (though see for example Clifford 1988; Kuper 1996; Sperber 1982). Rather, the aim is simply to explore briefly the related issues of observation, representation and translation in reference to local knowledge, and to outline the similarities between ethnographic and historical approaches. The extent to which local knowledge is embedded within a range of social institutions from which it may not be readily separable will also be discussed, with a view to examining this issue in more detail in chapter 4.

As was briefly touched upon in the introduction when discussing ethnobotany and ethnopharmacology, the simplest (or at least most direct) approach to learning from indigenous knowledge ignores any social factors in favour of focussing on locally developed technologies, the effectiveness of which can be tested empirically. This approach is perhaps best characterised as ethnoscience or as 'indigenous technical knowledge'. However, a short list of other possible synonyms or sub-disciplines presented by Sillitoe (1998: 223, footnote) includes terms such as 'rural people's knowledge', 'traditional environmental knowledge' and 'indigenous agricultural knowledge', all of which would seem to require both an understanding of local technologies and a consideration of management strategies and hence would also necessitate the study of associated institutions such as sumptuary laws, systems of tenure and inheritance rights. With its emphasis on material evidence and technology, archaeology would appear to be well placed to contribute to the study of indigenous technical knowledge, whilst the study of institutions of resource allocation falls firmly within the realms of social anthropology and human geography (see, for example, Brokensha, Warren and Werner 1980).

It is interesting, then, that in discussing possible approaches to what Andah (1995a: 151) terms a 'usable African past', Schmidt (1995: 137) focuses on "understanding what 'inherent scientific values' underlie and unify experimentation with the natural world" (see also Nicholas and Bannister 2004: 334), whilst Andah (1995a: 165) is more interested in the precedents set by local approaches to environmental management and sees the archaeological contribution to this area as heavily reliant on oral historical and ethnographic data. Yet even the apparently straight-forward recording of technical aspects of African iron smelting techniques as advocated by Schmidt (1995: 138) requires some degree of translation, since the combined archaeological and ethnographic evidence of African iron working practices demonstrate that this technology is deeply enmeshed within local cosmologies.

Discussing this issue in reference to ironworking in Cameroon, and drawing upon Van der Merwe and Avery's (1987) study of similar techniques in Malawi, Rowlands and Warnier (1993: 536) consider there to be three approaches to understanding the cosmological elements to technological processes. The first of these is to consider the non-essential 'ritual' processes that accompany technical operations as merely a method of protecting trade secrets by interweaving them with arcane and obfuscating behaviour. The second is to regard the non-technical component as a technology in its own right, whilst the third approach looks upon the ritual component as providing an explanation for the transformative processes involved in iron smelting, and thus also provides a suite of mnemonic devices which ensure procedures are carried out at the right time and in the right order. Rowlands and Warnier cite Kjekshus (1977: 91) as a proponent of the first view, Van der Merwe and Avery (1987) as following the second, and note that the third corresponds with Malinowski's (1948) functional explanation whereby the sanctified atmosphere provided by the ritualised smelting process forces the smiths to concentrate on the procedure, and acts to limit experimentation since this might be seen as contravening the precepts of the ritual. For their part, Rowlands and Warnier (1993: 537) consider the third approach to have merit but ultimately opt for a version of the second conception on the grounds that in the Cameroonian and Malawian case studies the smiths and smelters made no distinction between the 'ritual' and 'technical' aspects of the production process. Correspondingly, any attempt to make this distinction on the part of the ethnographer, archaeologist or ethnoscientist (if there is such a thing) requires them to introduce their own conception of causation (see also Collett 1993 in the same volume).

In exploring the implications of these various approaches, Rowlands and Warnier (1993: 538) turn to Lévi-Strauss (1966) to suggest that the knowledge of the local smiths can be equated with that of the *bricoleur*, in that it is functionally useful and internally consistent without requiring the in-depth understanding of an engineer, and come close to offering a more overtly structuralist analysis by noting that the local conception of technical production relies on the same binary oppositions (male, female; hot, cold; dry, wet) as those employed when discussing biological reproduction. In doing so, their intention is to show that the forces marshalled by the ritual aspects of the production process are not seen as unique to iron manufacture, and are instead part of a wider belief system that is employed in all other areas of life. In other words, the *techne* is understood from within the framework provided by a local *episteme*, and thus includes processes that are epistemologically necessary rather than technologically superfluous. To take an agricultural example, one might look to Evans-Pritchard's (1976 [1937]) discussion of the Azande of southern Sudan, since here the existence of witchcraft is (?was) invoked in explanations of event causation (not so much why things happen, but rather why physical events occur in relation to people) and is thus also employed to explain crop failures, and the possibility of avoiding such failures by the use of protective medicine (Evans-Pritchard 1976: 199-200; for alternative examples see Sillitoe 1998: 228 citing McCall 1995).

As with the Shambaa and Kwaio examples discussed above, interpretations that regard the ritual aspects of production as unnecessary are made on the basis that the causational scheme adopted by the enquirer contains no mechanism by which the ritual behaviour can effect the outcome of the manufacturing or cultivation processes (though note too that gravity serves as an example that failure to identify a mechanism does not necessarily invalidate an observation). Nevertheless, recourse to one's own conception of causation is a necessary and inevitable step in translating these processes for presentation to a western audience. Moreover, whether they want to or not, it is a necessary process in the ethnographer's attempt to reach an understanding of the process, regardless of the level of participant observation. Note, for example, that despite the terminology employed, the three approaches identified by Rowlands and Warnier are not mutually exclusive and are all functional explanations: all effectively assert that the local account of behaviour is mistaken, on the grounds that it performs some function that only the external observer can see. Thus even the interpretation that gives most respect to the local conceptions and technologies does so by noting that the 'ritual' or 'magical' components are necessary to avoid contradicting the wider epistemological framework that produced them; in Kuhn's terms they are necessary to maintain the paradigm. Indeed, Rowlands and Warnier (1993: 539) themselves later question why "some societies have developed their magical constructs out of proportion, and beyond what seems to be functionally adequate for grasping the technical processes", and thereby could be accused of undermining their own thesis that it is analytically meaningless to attempt to separate technology from epistemology.

Such an assessment, however, would be to confuse two distinct methods of analysis. From an ethnographic perspective, separating the ritual and productive elements would indeed be a poor description and thus misrepresent what the smith is doing, but it is impossible to understand and translate the production process without doing so. In other words, Collingwood's hierarchy of sciences is maintained since the local smith may be thought of as a *bricoleur* but his knowledge is still effectively overruled by that of the engineer, or is translated into a form that can be understood by the ethnographer's audience. Thus, whilst the historian and the ethnographer may wish to obtain a detailed description of all aspects of the production process in order to gain some insight into the beliefs and values of the protagonists, it is necessary to have some conception of what is occurring during the operation in order to define those aspects that are unique to the subject community. If one is merely concerned with assessing how the technology functions, in contrast, this cultural data is merely the superfluous paraphernalia that is left over after those behaviours with physical causative outcomes have been defined. The physical-chemical changes that occur in a furnace, or the biological transformations that occur in agricultural production, are simply those which can be most readily translated, since the western observer has access to a clear and unambiguous explanatory scheme that can predict under what conditions these transformations will occur.

If, however, it is accepted that the ritual components serve some useful function, then a proponent of the application of indigenous knowledge faces the problem that the local method of meeting this end may need to be replicated or, alternatively, it may be necessary to fulfil this function via some other mechanism. Whilst this might not represent a serious impediment in the smelting example suggested by Schmidt (1995), it is clearly more problematic in terms of systems of resource allocation or conservation as advocated by Andah (1995a). Sumptuary laws or rules that function to avoid overexploitation may not be easily replicable or enforceable, especially where the community providing the model relies on some form of ritual authority or a belief in cosmological retribution in order to avoid infringement (for example Hakannson 1989; Monson 2004). Problems of ethnographic translation, interpretation and representation may persist therefore, and it is for this reason that the promotion of indigenous management strategies cannot be thought of as simply applied institutional economics, since models that explain local behaviour in terms of, for example, the maximisation of prestige, 'social capital' or 'wealth in people' are essentially interpretive as opposed to predictive, or rather, they are models to be read as opposed to paradigms to be replicated.

In the context of development, therefore, proponents of institutional economics may be more likely to approach the issue of technology transfer from the other direction; not as promoters of the potential exportation or extension of local solutions, but as advocates for communities that may be affected by change, whether by developmental interventions or through the rapid assimilation of newly available technologies (Hobart 1993b; Stirrat, comment to Sillitoe 1998: 243; Sillitoe 2002). It is difficult to see how an historian could act as an advocate in this way, at least not in their capacity as an historian. Nevertheless, performing an advocacy role is still to act effectively as a translator.

Although clearly something of a truism, what is translated is inevitably influenced by what is translatable (Hobart 1982, 2000, particularly chapter 1), and hence translatability acts as a filter on ethnographic knowledge in much the same way as plausibility affects historical knowledge: conceptions that are incommensurate with those employed by the enquirer can be used to understand how and why an individual or community reacts to a given stimulus, but may nevertheless have to be rejected in order to produce a singular explanation of events

(Bourdieu 1977 cited in Parkin 1982). In Sperber's (1982) terms the ethnographer may therefore employ 'semi-propositional representations' (mental constructs that allow an individual to deal with information or concepts that he does not fully comprehend), a term that Sperber uses principally in relation to the kind of knowledge employed by Levi-Strauss' *bricoleur*, but which also applies to everyday abstract notions such as 'luck' or 'fate' (for example Evans-Pritchard 1976) or to ethnographic attempts to translate constructions with no clear western equivalency such as 'rythmed' or 'non-durational' time (for example Bloch 1977; Bourdillon 1978; Fabian 1983; Rowlands and Warnier 1993). Clearly, to accept that some concepts may not be translatable is an inherently cultural relativist position, and contrasts markedly with functionalist or structuralist perspectives which imply that the external observer is capable of not only translating 'indigenous' conceptions, but can see beyond local interpretations of them to their underlying structure or social function.

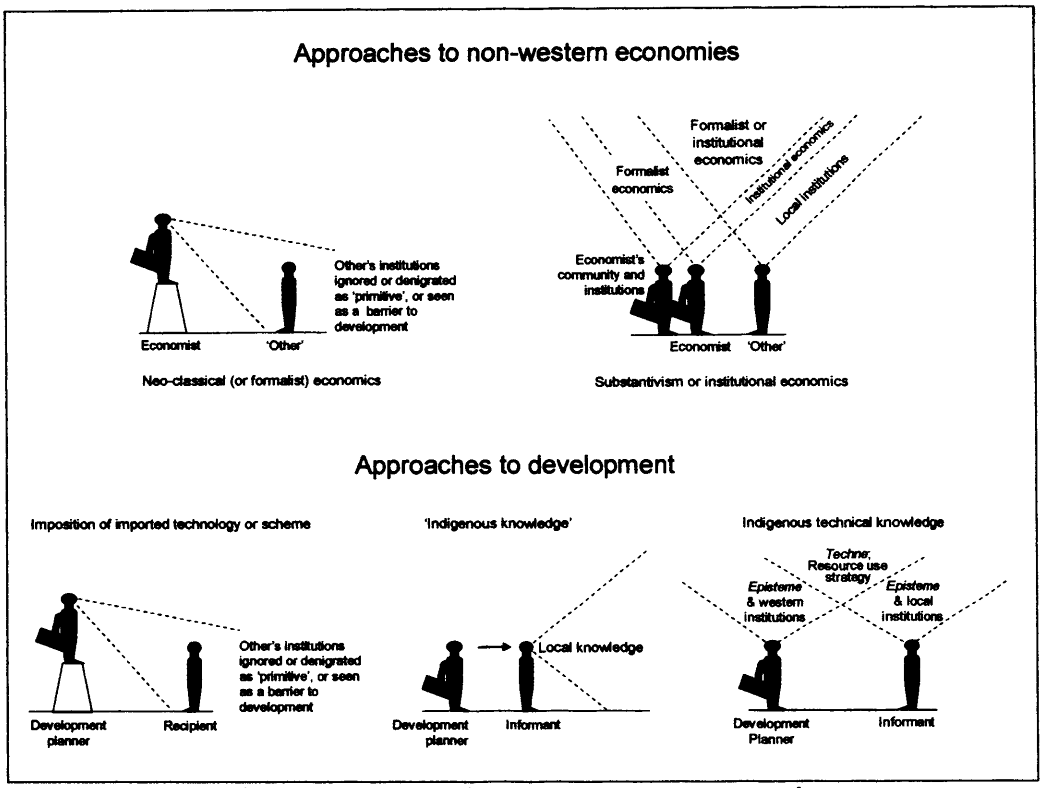

Figure 2.2: Approaches to non-western economies

To assert that perfect inter-epistemological translation is impossible, however, does not necessarily devalue ethnographic enquiry since some form of ethnographic knowledge is the closest an individual is likely to get to the indigenous knowledge of an 'other'. However, as with historical enquiry, it does mean that it is unrealistic to think in terms of definitive interpretations, or, as Parkin (1985:15) has put it, "Because different metaphysical schemes refer not to demonstrable universal traits, but to cultural presuppositions, the variations will always continue". Recourse to nature is unhelpful therefore, unless one is prepared to make the additional claim that there is something natural about the method of enquiry (see discussion of Feyerabend above). A possible alternative paradigm, then, is to shift the criterion of the success of ethnographic accounts away from explanation and towards understanding. From this perspective the ethnographic technique of participant observation can be thought of as a hermeneutic exercise (Geertz 1973) whereby the ethnographer aims to achieve what Giddens (1984) calls a "fusion of horizons", but it might equally be referred to via Collingwood's notion of re-enactment, with the caveat that whilst the construction of ethnographic or sociological narratives may influence their subject communities, this "double hermeneutic" (Giddens 1984) only applies to historical research where there is a possibility of dialogue between historian and source, and is thus restricted to oral historiographic enquiry (Lawi 2002). Yet, as Collingwood makes clear, re-enactment is a methodological device employed in the production of constructive histories, and hence Crapanzano's (1986: 75) criticism of Geertz could be levelled at any ethnographic or historical analysis: there is never "understanding of the native from the native's point of view. There is only the constructed understanding of the constructed native's constructed point of view".

Like historical research, therefore, the success of an ethnographic enquiry may be judged in terms of whether it accurately describes and represents the subject community; whether the interpretation of local behaviour consistently and coherently relates to the observations, and/or whether this behaviour is satisfactorily explained to a third party. Similarly, and again in common with history, claims to ethnographic authority cannot rest solely on the 'quality' of the sources, but must be partially based on the way these sources are interpreted. In the cases of both historical and ethnographical knowledge, the relative emphasis placed on methodology, evidence, and the assessment of what constitutes evidence in the first place, may vary between paradigms, but it remains a requirement that the enquirer at least claims to have sufficient knowledge of two communities (present, past; here, there or just academic, non-academic) to translate the conceptions of one for presentation to the other. This is clearly never an equal relationship since it is biased towards the communities that claim ownership of the methodology rather than those who might consider themselves owners of the source material, and thus even calls for subject communities to 'write back' (see, for example, the various contributors to Clifford and Marcus 1986) or for the production of polyphonic or dialogic ethnographies (ibid. and Clifford 1988: 46-50) still privilege those groups that claim the right to validate the information contained therein. Yet neither ethnographic nor historical research has defined any method of invalidating local claims to knowledge, and indeed Collingwood's (1940) rejection of attempts to question absolute presuppositions effectively echoes the stance taken three years earlier by Evans-Pritchard (1976 [1937]). Absolute claims of the form 'you are wrong' are thus replaced by more overtly subjective statements along the lines of 'I disagree'.

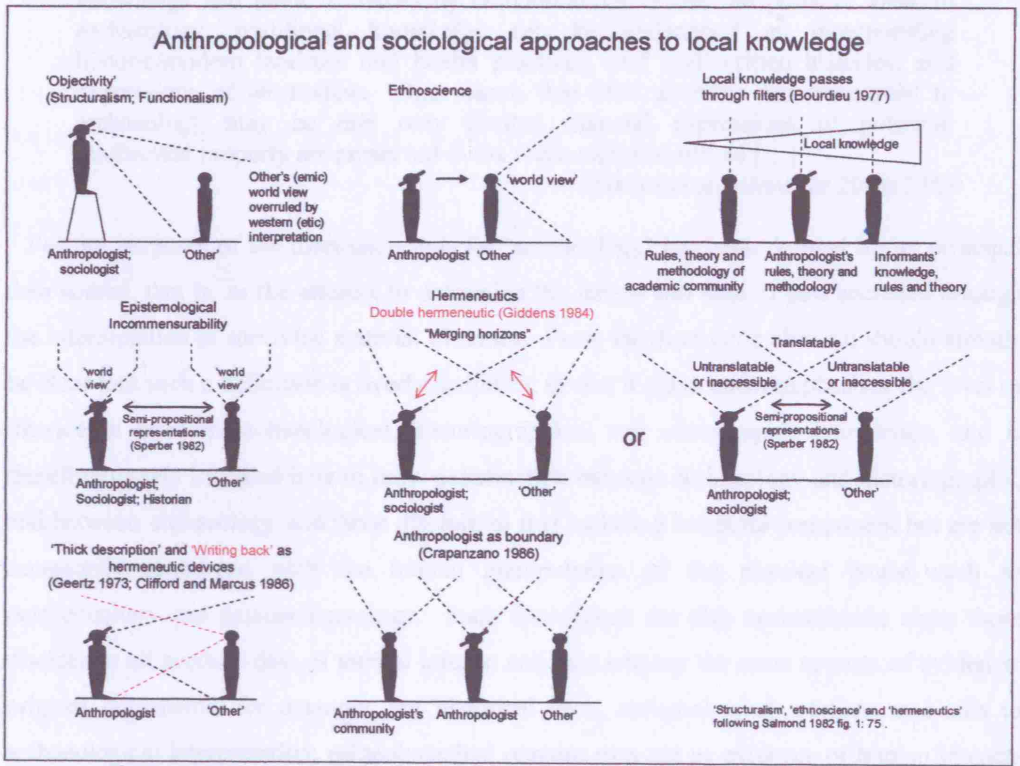

Figure 2.2: Anthropological and sociological approaches to local knowledge

By citing the work of writers such as Collingwood, Kluckhohn and Evans-Pritchard, the intention has been to show that the issue of epistemological incommensurability is not a purely postmodern concern, but it is nevertheless apparent that several of the approaches briefly summarised here were prompted by related postmodern and poststructuralist critiques of representation and, in particular, of the extent to which claims to objectivity could be employed to denigrate local knowledge. The advocacy of the use of local technologies and management strategies could itself be seen as a response to these various postmodern positions, either as an expression of loss of faith with modernisation schemes or, on more theoretical grounds, as an anthropological interpretation of Kuhn's criterion for the judgement of a paradigm's success. Recognising that ethnographic knowledge cannot be simply equated with the local knowledge employed by ethnography's subject communities is, however, to acknowledge simultaneously that the term 'indigenous knowledge' is generally short-hand for 'indigenous knowledge as defined and validated by western knowledge'.

Can archaeology see indigenous knowledge?

> Is access to a site by archaeologists any different from access to traditional knowledge and plant resources by ethnobotanists? From the point of view of archaeology, traditional knowledge can be understood as incorporating historic/modern land-use and health practices, oral and written histories, and expressions of worldview. One reason that little attention has been paid to archaeology may be that only limited material expressions of potential intellectual property are preserved in the archaeological record [...]
>
> (Nicholas and Banister 2004: 330)

For the purposes of the discussion thus far 'archaeology' has been defined by its principal data source, that is, as the attempt to determine the nature and date of past societies through the interpretation of surviving material evidence. From the discussion above it should already be clear that such a definition is overly simplistic in that it plays underemphasises the level of interaction between archaeological, historiographical and ethnographic knowledge, and is therefore merely included here to draw a distinction between archaeology and historiography, and between archaeology and those disciplines that include a temporal component but are not necessarily concerned with the human manipulation of the physical world such as palaeoecology and palaeoclimatology. Such distinctions are also unsustainable since these disciplines all produce data of mutual interest and may employ the same sources of evidence: original documents, for example, are historical texts, archaeological artefacts and aids to archaeological interpretation; palaeobotanical remains may act as evidence of human impacts on past environments, or may simply serve to place historical communities in their ecological context. Nevertheless, by focussing on material remains, archaeology has access to communities that are not recorded by either documentary or oral historical sources, which include not only non-literate or prehistoric societies but also those individuals and groups within communities whose lives are not the subject of historical record. If this temporal depth and ability to study the lives of all sections of a community represent archaeology's principle strength, then its major weakness is its frequent inability to gain direct access to local conceptions and institutions. In terms of the current study, therefore, the problem is less a question of whether archaeological techniques can retrieve information about the resource use strategies of communities in the past, and is instead a question of whether this evidence is likely to be of sufficient detail to allow the reconstruction of the practical knowledge employed, and the definition of the social and economic institutions involved in the management of resources. Before examining this issue in relation to the current project's case study, it is worth exploring how archaeological theorists have approached forms of knowledge that contain conceptions incommensurate with their own.

In a sense, the separation between archaeology and historiography defines the parameters of this issue from an archaeological perspective, and indeed one of the features of the 'new' or processual archaeology of the 1960s and 1970s was a mistrust of the subjectivity of textual and oral sources, and a corresponding emphasis on prehistory as the 'proper' area of archaeological study on the grounds that this allowed the objective collation of data and thus the construction of general models of human behaviour (for examples see contributions to Binford 1977; for discussion see Trigger 1989 and Knapp 1996: 141-2). At the risk of presenting something of a caricature, processualism was therefore apt to view the culturally specific ways in which communities conceptualise their subsistence strategies and technologies as less significant than these strategies themselves. From this standpoint, ethnography's emphasis on 'culture' (however that is defined) is unlikely to provide the detailed descriptions of behaviour necessary to refine archaeological interpretations and, in consequence, could be viewed as a poor substitute for the collation of ethnoarchaeological observations, since the latter process can prioritise the recording of those activities likely to leave archaeological traces, or can help explain why in certain circumstances no such traces are found (for example Schiffer 1978; Stiles 1977).

Though far from a unified project, the critics of processualism can be broadly grouped together through a shared interest in how archaeological knowledge is produced and authenticated, and are commonly referred to by the somewhat ungainly term 'post-processualism'. Incorporating many of the perspectives touched upon above, post-processualism can be characterised as composing what might be thought of as two contradictory tacks, one of which draws upon anti-foundationalist and poststructuralist standpoints to argue for the local rather than absolute nature of knowledge claims, whilst the other takes the essentially empirical approach of arguing that the diversity evident in the ethnographic record is likely to reflect that of communities in the past, and thus that this variety does not support the view that human behaviour can be reduced to simple predictive or deterministic models (Wylie 1993: 25; see also Raven, comment to the Lampeter Archaeological Workshop 1997: 186-7 and, from a slightly different perspective, Lane 1996: 728). Thus, as examples, Shanks and Tilley (1987) draw heavily upon Feyerabend and Kuhn, whilst Bapty and Yates (1990) make considerable use of Derrida's (1982b) critique of Saussurian binary oppositions to dismiss the notion of definitive archaeological interpretations, and Tilley (1991) employs an approach inspired by Foucault to argue that the will for historical 'truth' is always associated with knowledge/power within discourses. Hodder's critique of culture-historical and processual approaches, in contrast, employs ethnoarchaeological research to highlight problems with assuming simplistic relationships between artefact styles and 'ethnic' groups (1982), and later argued for a cultural relativist position (1986), for which the acknowledged inspiration was Collingwood (principally 1946).

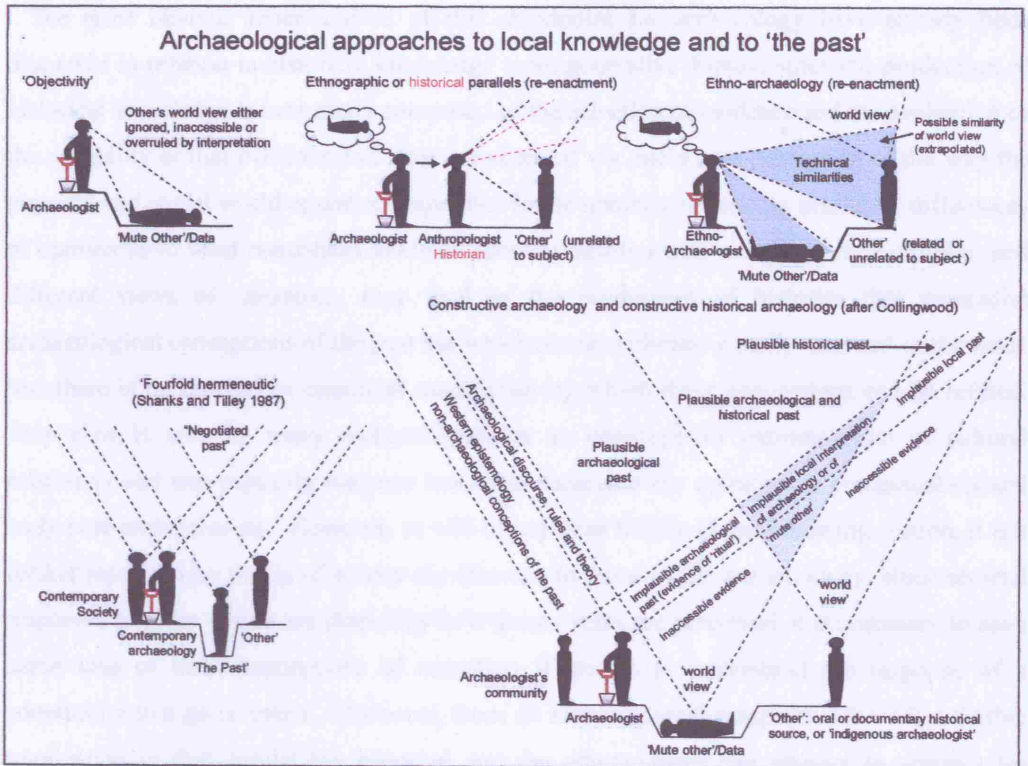

Figure 2.4: Archaeological approaches to local knowledge and to 'the past'

The postmodern/poststructural and empirical elements of the post-processual critique can be reconciled, however, by noting that, like ethnography and historical research generally, archaeology is founded on an empiricist absolute presupposition from which it follows that the discipline is constructive in Collingwood's terms, and should thus be seen as the product of an epistemological framework from which it cannot escape without compromising its own tenets of consistency and logical coherence. In this light, the body of data pertaining to 'indigenous' worldviews produced by both ethnography and historiography illustrates the existence of a diverse range of communities in which concepts are employed that are incommensurate with those upon which archaeology relies, and thus demonstrates that, for all intents and purposes, "the societies of the world are not more or less 'correct' images of a *single* reality but are themselves differing realities, constructed again and again in relation to those around them, by human thought and action" (Inden 1986: 446). Put simply, even if archaeology as a discipline generally maintains a belief in a single concrete reality (Gellner 1985) and regards alternative views of this reality as simply culturally specific perceptions and interpretations, this does not alter the fact that deities are very real to a devout believers; witches were (are?) very real to the Azande (Evans-Pritchard 1976); time is cyclical within many belief systems (Fabian 1983).

The most obvious repercussions of this standpoint for archaeology have already been discussed in relation to historical knowledge more generally. Firstly, since the production of historical knowledge is essentially composed of the selection of evidence and the evaluation of the reliability of that evidence and its source/context via one's own perception of the way the physical and social world operates, disparities in the quantity of sources available, differences of opinion as to what constitutes evidence (communication with ancestors, for example), and different views of causation, may lead to the production of histories that contradict archaeological conceptions of the past but which are nevertheless equally 'correct' in the sense that there is no rational or empirical mechanism by which these conceptions can be refuted. This view is seen by many archaeologists as an unacceptably extreme form of cultural relativism and was arguably the core issue that separated the opinions of processualists and early post-processualists. However, as will be explored briefly in the following section, it is a further repercussion that is of greater significance in terms of the current study: since societal responses to given events are shaped by how those events are perceived, it is necessary to have some idea of local conceptions of causation if one is to understand the response of a community to a given event. Moreover, from an archaeological perspective there is a further implication in that, whilst the historian and the ethnographer can attempt to account for conceptions that are incommensurate with their own through the process of re-enactment, without direct access to local conceptions or detailed information relating to social institutions, the archaeologist either does not have this ability, or is forced to extrapolate this information from analogous or related communities. This can be achieved either by studying these groups directly (ethno-archaeology or historical archaeology) or by referring to the work of historiographers and ethnographers. Either way, this introduction of an additional subjective step in archaeological interpretations must be seen as a limitation in terms of archaeology's ability to reconstruct indigenous resource exploitation strategies.

Archaeology and cultural relativism

> The criticisms of an unrestrained relativism are many, various and irrefutable. It is demonstrably wrong: archaeology has 'progressed', we no longer believe in the Creation of 4004 BC. Relativism involves a logical fallacy: 'all views are of equal value - including this one'. Relativism undercuts the value of archaeology as a form of knowledge about the past, and if pursued to its logical implication would do archaeologists out of a job. For many, the most fundamental and damning criticism of relativism is that it destroys our ability to speak out about politically undesirable and even obnoxious views of the past, the classic example being Holocaust denial groups. We might wish to acknowledge the validity of different views [...] but who would suggest that this means we have to acknowledge racist views as of equal value?
>
> (Johnson 2000: 172)

The quotation above is perhaps stated more bluntly than most, but does at least succinctly and honestly summarise the dangers that some archaeologists feel a claim to objectivity keeps at bay. From its tone and the inclusion of unusually definitive terms ("irrefutable"; "demonstrably wrong") it is clear that the chief concern is with maintaining archaeological authority, and that the intended audience is archaeologists (the threat of impending professional redundancy being unlikely to strike fear into the hearts of the masses). However, the possibility that archaeology serves some wider societal function is raised via the notion of 'progress' and through the discipline's ability to challenge "politically undesirable", "obnoxious" or "racist" conceptions of history. There is thus a moral, and therefore of course subjective, element to this case, but there is also an attempt at a theoretical argument through the assertion that "Relativism involves a logical fallacy". Several of these points have been touched upon above, but it is worth addressing them in slightly more detail, not least because they are paralleled by comments made elsewhere (for example Renfrew 1989: 34; Trigger 1989: 381, 406, 778 and 791; Kohl 1993: 16; Preucel and Hodder 1996: 528; Hodder 1999: 6; see also various further comments cited by the Lampeter Archaeological Workshop 1997: 164-5) and because they have a bearing on the 'paradox' facing African archaeology as identified by Schmidt (1995: 119) in the quotation that heads this chapter. Indeed, despite Ucko's (1995) appraisal in the mid-1990s that current attitudes among archaeologists could be characterised as relativistic, by the end of the decade Hodder (1999: 153) described archaeology's relationship with relativism as having been a mere "flirtation".

However, as was touched upon in the introduction, this assessment that archaeology completely rejected relativism is somewhat misleading. Legislation enacted in many countries that requires that all threatened archaeological remains are at least investigated and recorded owes less to a conservation ethic and more to the realisation that there is no objective way to gauge the importance of sites, and that to prioritise some sites over others risks being seen as favouring those contemporary groups that identify themselves with these remains (Kristiansen 1989; the heritage projects at the Zimbabwean sites of Old Bulawayo and Great Zimbabwe have also recently been discussed in these terms – Pwiti 2005). The contrary position, that blanket protection results from a conservation ethic (for example Cleere 1989 and 1993) or is based on purely archaeological criteria (Schaafsma 1989: 47) does not address the question of why the past was considered important in the first place. Cleere (1989), for example, expresses surprise that in the late nineteenth and early twentieth centuries the British government afforded more legislative protection to Indian antiquities than it did to its own. This would indeed be surprising if the rationale behind this protection was one of conservation. It is not surprising, however, when it is considered that Britain did not need to appropriate its own past but that it was politically expedient to expropriate India's (Cohn

1983). That similar legislation was not passed throughout colonial Africa is simply a reflection of the alternative approach whereby, not faced with the obvious monumental architecture and literary history so evident in India, it was simpler to present African communities outside Egypt as historically static and thus, by implication, as not in possession of a past worthy of legislative protection. Nevertheless, it remains true that despite this relativist element, the assertion by archaeologists that they are the group most qualified to manage so called 'heritage resources' rests on an assertion of disciplinary authority that is itself partially based on a claim to objectivity (see above p. 23 and 28; Wylie 2005 also discusses this issue, albeit from a slightly different perspective).

Questions of authority are of course related to assessments of authenticity, since claims to authority must be coupled to an assertion that the past revealed through the use of archaeological techniques is more authentic – more true (Ucko 2005). It is interesting, therefore, that the debate surrounding relativism is generally couched in terms of how, or by what right, can archaeologists attempt to convince others that archaeological images of the past are correct, rather than examining this formula from the opposite direction: in what ways do local conceptions of the past differ from those produced by archaeology, and what are the implications in terms of archaeology's ability to model local history? Indeed, for largely rhetorical reasons, indigenous conceptions of the past are very often ignored entirely in these theoretical discussions in favour of focussing on marginal or extreme views from groups or individuals within western societies. Johnson may appear, therefore, to be taking an unambiguously moral line in highlighting the use of historical arguments by racists or holocaust denial groups, but he nevertheless faces the same problem as those who are more concerned by "cranks", "extra-terrestrial salvationists" (Trigger 1989: 406) or "believers in Von Daniken and mother goddess cults" (Hodder 1999: 6). Thus, whilst archaeology clearly can, and has, challenged racist conceptions of the past (famous and recent African examples include Garlake 1973 and Reid 2001), it does so by demonstrating that these conceptions are based on the selective use or misrepresentation of evidence, and therefore can only challenge such views directly if they are presented via a 'scientific' or 'academic' idiom. In other words, an archaeological refutation always takes the form of a statement that disciplinary criteria of evidential evaluation lead to images of the past that do not support the challenged view. If these criteria are not accepted, or are simple ignored, then it would be somewhat disingenuous to describe any exchange of views as a debate (Lampeter Archaeological Workshop 1997: 172). It is one thing to challenge holocaust deniers legally (the events in question are crimes and therefore susceptible to adjudication via systems that employ criteria of evidential constraint that are essentially shared by archaeology or historiography), but it is quite another to regard "politically undesirable" or "obnoxious" views of the past as fundamentally different in character from those expressed by other non-mainstream groups.

Approaching this problem from a slightly different direction, Sperber (1982: 48) notes that "statements can be made with quite different purposes and with great variety of degree and type of commitment [...] criteria of rationality may vary with types of statements and classes of 'beliefs' ". The level of evidence acceptable to proclaim a belief in the existence of, for example, the African Aqualithic, may, therefore, be more stringent than that required to assert a belief in the existence of extra-terrestrials or a mother goddess. A failure of some anthropologists, argues Sperber, is that they have considered various worldviews irrational by wrongly placing them in that category of beliefs that requires interdependence and consistency for their validation; that is to say, they judge knowledge claims by the criteria that they themselves are professionally obliged to fulfil. Writers such as Von Daniken (1968) and Hancock (1995) can certainly be seen in this light. Such people are neither practising archaeology nor attempting to practice it. It is one thing to say that archaeological canons of coherence and evidential constraint cannot support their conclusions, but it is quite another to dismiss them for failing to adhere to the rules of a community of which they are not members. It is precisely for this reason that archaeologists do not produce texts entitled *The Idiocy of the Maya* or *Insane Cosmological Nonsense from Ancient Egypt*. This is, however, a subtle form of ethnocentrism: separated by their distance in the past, 'ancient' communities are forgiven their 'mistakes' due to their lack of access to post-Enlightenment scientific advances in much the same way as 'irrational' or 'mistaken' beliefs entertained in medieval Europe are forgiven. 'Cranks', on the other hand, have no such excuse as they have been given every opportunity to embrace mainstream thinking yet foolishly or bloody-mindedly refuse to see the errors of their position and can thus be vilified accordingly. Where then, does this leave modern communities who maintain beliefs that rely on conceptions that are just as incompatible with modern scientific thinking? Who are the 'we' referred to by Johnson that no longer believe in a creation, regardless of date? Is this not an example of the use of archaeological authority in order "to control, to dominate, to set up barriers, disqualify, alienate" (Tilley 1991: 175)?

From this perspective the problem with Johnson's (2000: 172) identification of a "logical fallacy" within (archaeological) relativism becomes much clearer. Relativism is itself a product of an epistemology that is built on tenets of logical coherence and empiricism; it is not a mode of enquiry so much as a recognition of context and a statement regarding comparability (Fardon 1988: 16). It does not offer a solution to problems of inter-cultural explanation or translation, since to acknowledge the contextual validity of other worldviews is to acknowledge simultaneously that they are incommensurate with one's own. Like Kuhn's competing paradigms, it is this incommensurability that makes it possible for them to be internally consistent yet produce different conclusions. The identification of a logical fallacy seems, therefore, to result from the misconception that in acknowledging the validity of other views, relativism somehow encompasses them, or that these views are seen as valid because they are bound by the epistemology that produced a belief in relativism. On the contrary, other worldviews are not valid because they have been found to be valid, they are valid because their incommensurability means there is no objective, rational, logical or empirical way of *invalidating* them. The logical fallacy perceived by Johnson therefore does not arise, since recognising the validity of incommensurate worldviews is itself a result of the need or desire to be logically consistent.

In an attempt to refine this position further Shanks and Hodder (1996: 19) and the Lampeter Archaeological Workshop (1997: 169) cite Bhaskar's (1979[4]:57) distinction between epistemic relativism ("beliefs are socially produced, so that all knowledge is transient, and neither truth-values nor criteria of rationality exist outside of historical time") and judgemental relativism ("all beliefs (statements) are equally valid, in the sense that there can be no (rational) grounds for preferring one to another"), of which only the former is held to be correct. However, whilst the Lampeter group employ this distinction to make the point outlined above that relativism cannot be simplistically regarded as self-refuting or contradictory on the grounds that a relativist position is itself relative, Shanks and Hodder attempt to push this point further to argue not just that some archaeological interpretations may be better than others (for example they may present a narrative that takes account of more sources of evidence) but that archaeological interpretations may be more correct than interpretations based on some other set of epistemological criteria; some other absolute presuppositions. This seems to be going beyond the point Bhaskar is making since it is no less 'rational' to 'prefer' a belief in, say, a creator, than it is to favour a belief in evolution through natural selection[5], since this preference may be made on the basis of a variety of criteria including received cultural conceptions; notions of plausibility; or through essentially aesthetic concerns such as drawing comfort from a belief in a divine guiding influence or in the possibility of human understanding of the physical world. Once again, expressing and justifying a preference is not the same as invalidating the views of others, since the process of invalidation assumes some consensus as to the terms of the discussion. Similarly, when Inden (1986: 446) argues that different conceptions of the (specifically Indian) past should be seen as

[4] The current study consulted the third edition of 1998.

[5] Although one might assume that the incommensurability of creationist and evolutionist perspectives is now well understood, the issue was repeatedly raised during a recent seminar series entitled 'African Peoples and Pasts' at the Institute of Archaeology, and in particular following papers presented by Lane (2004), Rowlands (2005) and Ucko (2004).

differing realities and suggests that this would avoid "lapsing into atomistic moral relativism", it is not clear how many such realities he expects there to be, but it is certain that this would not result in a simple pairing of 'Indian' and 'non-Indian' worlds (see, for example Appadurai 1981). In practice, therefore, even if one attempts to constrain judgemental relativism by limiting it to those worldviews that have been defined through historical or ethnographic research, the existence of multiple perspectives and the huge variety of possible scales at which these perspectives could be viewed, means that epistemic relativism will produce a situation that is so close to judgemental relativism as to make no difference.

Yet to assert that "relativism undercuts the value of archaeology as a form of knowledge about the past" (Johnson 2000: 172) seems a somewhat extreme conclusion given that the position in no way supports the view that archaeological or historical narratives are necessarily incorrect, merely that they have to be seen in the context of the epistemology that produced them. Seen in this light, the suggestion that it may be possible to reach a consensus by adopting a pluralist, rather than relativist, stance (for example Shanks and Hodder 1996: 18) seems not just redundant but actually counterproductive, in that pluralism without relativism is the same as saying 'you can have your say but it is wrong'. Attempts to employ the concept of democracy in interpretations (for example Preucel 1995: 161) – apparently in a manner akin to that suggested by Feyerabend (1975) – are beset by similar problems which are also shared by those who talk of the production of archaeological knowledge as a process of negotiation (Schmidt 1995; Shanks and Tilley 1987) in that the archaeological method allows little room for compromise in terms of plausibility or of what can be regarded as evidence. Nevertheless, arguably the central problem with both pluralism and negotiation in terms of archaeology is that both are focussed towards alternative beliefs about the past held in the present, yet neither have any relevance as regards beliefs held by those communities that form archaeology's object of study.

Similarly, arguing that sources of evidence provide "networks of resistance" (Shanks and Tilley 1987: 104) which demonstrate that the past is "partially objective" (Hodder 1992: 191) quietly ignores the issue that the factors that constrain these interpretations (plausibility, logical coherence) are epistemologically specific. Thus, whilst it is true that from a empirical perspective these data are never "entirely plastic" (Wylie 1995: 125), this is merely a description of how archaeological arguments are constructed and validated and, again, would require an additional claim to an objective foundation if it is to be invoked as a method of invalidating other conceptions of the past (ibid.). As noted above, it is the materiality of archaeological evidence that appears to make such a claim reasonable. Shanks and Hodder (1996), for example, assert, on the grounds of common sense, that to see objectivity as completely constructed (i.e. as bias masked as impartiality) would seem to imply that there is no real past, and that correspondingly "it is silly to think that the distance between survey transects is something to do with politics" (ibid.: 19). Consequently, it is asserted, reality can be tested by its resistance: "kick a megalith and it hurts – it is very real" (ibid.: 20; see also Siller in the Lampeter Archaeological Workshop: 181 "If an axe lands on my foot it's 'real', we may call it different things, describe different attributes and have different explanations for it, but it still hurts"). This may be so, but statements of this sort refer to observation, not interpretation, and make the mistake of assuming that the subjectivity of historiography is wholly the result of the subjective nature of the source material (Collingwood's common sense history) and ignores the subjectivity of the historian (constructive history).

The reality of the megalith in the above example may not be in question, but what makes it archaeologically interesting, indeed what makes it an archaeological source in the first place, is that it is not a 'natural' geological feature and is instead a product of human activity. Moreover, it is the product of an activity that goes beyond the simple satisfaction of human biological needs, and therefore defies simplistic interpretation. Similarly, as Sillar himself effectively acknowledges, the pain induced by his dropped axe is unlikely to provide him with the motivation to seek out the witch responsible; a point that is illustrated elsewhere in the Lampeter workshop discussion when it is noted that in seventeenth-century western Europe, prehistoric stone tools were regarded as a physical manifestation of thunderbolts (Lampeter Archaeological Workshop 1997: 169-171). Indeed, even the example of transect spacing is not entirely unproblematic, since, as is discussed by Andah (1995a: 154-6 and 172; 1995b), north American and European archaeologists can be reasonably accused of having failed to identify certain African social phenomena by looking for them at the wrong spatial scale, for example, by assuming that state-level social complexity must always be associated with the development of urbanism (see also, for example, McIntosh and McIntosh 1993). Since the perceived lack of precolonial social complexity in Africa was invoked as a justification for the imposition of colonial governance, and assessments of the absence of this complexity were based on European derived models, it could indeed be argued that survey methodology has 'something to do with politics'.

Either way, this recourse to objectivity by pointing to the self-evident reality of archaeological source materials actually highlights that archaeological arguments often insert an additional subjective element that may not be necessary in historiographical research, since the historiographer is likely to have access to statements that give some indication of the subjective way individuals in the subject community perceived their world, whereas the archaeologist might not. Thus, in Shanks and Hodder's megalith example, the sheer physical reality of their object may indicate that it was considered important by the community that expended effort in its construction or erection, but this does not, of itself, explain why it was thought significant. The common archaeological response to this problem is to search for ethnographic or historical analogies of similar occurrences that might be used to provide this missing explanatory detail, and it is this process that effectively introduces a third subjective perspective: not just historian and subject community, but historian, subject community and ethnographic or historical 'other'.

'Ethno-', 'indigenous' and 'applied' archaeologies

> Thus, directly or indirectly, Western social science, including archaeology and history, has been and continues to be an extension of a power system that imposes its ideology and its socioeconomic system as the only valid cultural system for the world. Western scholars usually have had an unequal relationship with their African subjects of study (directly in history and anthropology, indirectly in archaeology). Information from local ethnographers, oral historians and other informants is seldom obtained in a fair and open climate devoid of pressure. The Western-trained researcher usually occupies the driver's seat rather than the learner's seat, guiding and shaping what informants, living or dead (e.g., sites and artefacts), reveal.
>
> (Andah 1995a: 158)

Despite the implication in processual approaches to ethno-archaeology (for example Schiffer 1978; Stiles 1977) that direct observations of indigenous practices can be seen as unproblematically empirical, this is arguably only the case where research is focussed towards physical processes of site formation (Agorsah 1990; Lane 1996). Once human agency enters into the equation, however, the use of ethnographic or ethno-archaeological observations in archaeological interpretations generally take the form of analogies (rather than the more loaded term 'ethnographic parallels'), and are thus simply a tool in the necessarily subjective historical act of empathetic imagination (or re-enactment – Collingwood 1946). That is to say, perceived similarities between an extant community and the community under archaeological investigation may suggest other possible points of convergence and thus help refine archaeological interpretations, but inferences of this kind are still effectively based on imagining how the protagonists may have behaved or thought, with the analogous community's thoughts or actions employed as guides. As such, whilst the use of analogies may help narrow the range of plausible speculation or even suggest innovative interpretations, they cannot be seen as somehow reducing the subjectivity of the resultant conclusions. Indeed, just as ecological determinist models can be challenged by an ethnographic record that demonstrates a huge variety of possible responses to what is effectively a very short list of biological needs, so this same body of evidence could be employed to demonstrate precedents for a host of possible archaeological interpretations. This effect can be limited, of course, by selecting analogies that are as 'relational' (Hodder 1986) as possible, yet the selection of the most appropriate comparison may not be self-evident, and even a direct historical approach that attempts to combine ethnographic information of a given community with archaeological data pertaining to that community's past, must still be seen as primarily a process of re-enactment, not least because to assume continuity of practice is to risk re-enforcing the stereotype that non-western societies are inherently conservative and technologically static (Lane 1996: 728; Stahl 2001: 21-2).

The potential political ramifications of ethno-archaeology are now well understood however, and most archaeologists are therefore at pains to distance themselves from the implication that the analogous community are archaic relicts of, or no more 'advanced' than, the community under archaeological investigation (see, for example, MacEachern 1996). In line with the sentiment expressed in Andah's statement above, it may be preferable, where possible, to treat local actors not as sources of analogous behaviour but as sources of alternative interpretations, and thus move towards redressing the unequal relationship between observer and observed (Lane 1996: 730). Such a position has an evident relationship with subaltern studies and notions of 'empowerment' (see, for example Wylie 1995: 268 and 271-2) and thus criticisms of this kind have led to calls for the establishment of 'indigenous archaeologies' (for example Hodder 1986). Indeed, as Lane (1996: 729) points out, the use of physical remains in the construction of historical narratives may be a human universal and therefore indigenous archaeologies could be said to exist already, yet this of course does not mean that these local approaches to physical evidence will articulate with orthodox archaeology any better than local histories correlate with western historiography.

Once again, elements of the local narrative that the archaeologist's community would see as implausible might offer insights that can be employed in archaeological interpretations and suggest how the subject community may have seen their world, but the archaeologist's account of what 'actually' or 'probably' occurred employs these conceptions merely as explanatory detail. In other words, and to paraphrase Mudimbe's (1988: 19) comment regarding anthropology 'it is impossible to imagine an archaeology without a western epistemological link' since "as a science, it depends upon a precise frame without which there is no science at all". We may wish to refer to local approaches to the physical remains of the past as 'archaeologies' if that helps distinguish them from accounts based on testimony or tradition, but the mere act of drawing a distinction between 'indigenous archaeology' and archaeology 'proper', demonstrates that these alternative approaches are likely to rely on conceptions that are mutually incommensurate.

Note, for example, that whilst Schmidt (1995: 146) observes that African ritual events or locations may be remembered or marked by features such as sacred groves or shrine trees, his statement that "In many cases these indigenous African archaeologies are accessible to Western techniques of investigation" does not bring him any closer to addressing the dilemma expressed in the quotation that heads this chapter, since no mechanism is presented whereby, for example, the archaeological dating of a shrine tree could be reconciled with conflicting dates provided by local genealogies (see also Oliver 1959). Schmidt's (1995: 137) earlier point that local approaches to technology are 'inherently scientific' is certainly unhelpful in this regard, and again, however well intentioned, simply serves to encompass local techniques and conceptions within a super-ordinate framework provided by western science. Similarly, despite Andah's (1995a: 173) advocacy of the use of oral historical and ethnographic data in order to "gain entry into the fabric of African knowledge systems", his suggestion that oral historical data would need to be "tested" empirically (Andah 1995a: 174; see also Wylie 1995a: 266) would seem to indicate that he feels that one is capable of being validated by the other (contra Andah 1995a: 159).

Nevertheless Andah (1995a: 173) is no doubt correct in asserting that an understanding of local knowledge systems is a necessary prerequisite if the "social and environmental plans and designs of past populations" are to be fully comprehended, yet by suggesting that ethnographic and oral historical sources are the best means of gaining access to this knowledge it is evident that Andah recognises archaeology's inability to do so unaided. However, as will be explored further in the following two chapters, problems of selecting and translating analogies persist, whilst the issue of epistemological incommensurability means that the accounts produced by this process may not conform to those produced locally and, more damningly, may not accurately reflect the experiences of the community under examination. Rhetorically talking of the negotiation of pasts when to do so would represent an unacceptable disciplinary compromise does not resolve either of these problems. On the other hand, characterising plausible historical narratives as constructive rather than reconstructive, though also often employed as a rhetorical device, does at least honestly summarise the process of historical knowledge production and thus serves to place this knowledge in its proper context. An applied archaeology, however, may be in a position to push this point further and thus move closer to addressing Schmidt's dilemma. By being open about the nature of archaeological narratives as hybrids of the material indices of the past combined with models of behaviour either drawn from the present or seen from the perspective of the present, an applied archaeology may be capable of contributing to both historical and developmental narratives, and could even drop any claim to be producing a past that is more accurate than those produced locally, by focussing instead on the relationship between plausibility and functionality in the production of archaeological models.

Thus, depending on the relative quantity of data drawn from the past and the present, archaeologists produce models with varying degrees of historical certainty expressed as either 'what may have happened', or 'what probably happened'. An applied archaeology might simply take this process a step further by employing modern data sources such as ethnographic analogies without the pretence that these make the resultant models more accurate (i.e. a better reflection of the past), but solely on the grounds that they make the model function. As with the conservation of archaeological sites or artefacts, such a process would make explicit what was original and what was interpretively constructed, and has the advantage that it does not treat the technical knowledge or resource use strategies of modern communities as simply perceivable substitutes for the inaccessible knowledge of the archaeological 'other'. Implications that these present day societies are somehow archaic are thus avoided, and the resultant models would represent a genuine combination of the knowledge of past societies defined through archaeology and historiography, with the knowledge of modern communities either applied directly or defined and translated through ethnography and human geography (for example Erikson 1993, 1998). Moreover, such an approach maintains the option of employing technologies or crop varieties that were unavailable to the communities in the past (ibid. and Evenari, Shanan and Tadmore 1971).

However, as was noted in the introduction, the archaeological component to a multidisciplinary project of this sort would still need to address the same questions as any conventional archaeological enquiry, and indeed could not hope to contribute to broader developmental debates were it not to do so. From the perspective of these debates, the discipline's primary contribution remains its ability to place local strategies of resource use in their long-term historical context and, as such, the following chapters will explore the history of east African intensive agriculture with a view to assessing what archaeological enquires can draw from, and add to, this picture.

3

Precolonial African intensive agriculture: themes and examples

> Agricultural landscapes are human creations, apprehended through culturally constructed perceptions and practices and, in part, physically constructed through intentional and unintentional human modifications of the natural environment. The physical and cultural landscape of agriculture is a transformed environment that, moreover, is constantly remade as strategies of agricultural production change through time. It is also an environment in which context matters.
>
> (Morrison 1996: 583).

As Sutton notes in the opening sentence to an article on the history of African field systems, "there is no such thing as an *ordinary* field; nor are there *typical* techniques of cultivation" (1989b: 98). As such, loosely grouping distinct and disparate agronomies from across sub-Saharan Africa under the banner of 'precolonial African intensive agriculture' risks masking the sheer variety in form and function demonstrated by these local adaptations. That having been said, the areas to be discussed here are broadly analogous in that they all include modifications of the landscape in the form of either terraces or water management systems which are constructed to either enable or prolong arable production. They have thus been cited, either individually or collectively, as potentially useful sources of agricultural and ecological indigenous knowledge (see, for example, discussions within Adams 1989, 1996, 2004; Adams and Anderson 1988; Adams, Watson and Mutiso 1997; Amborn 1989; Fleuret 1985; Grove 1993; Sheridan 2002; Ssennyonga 1983; Sutton 1989b; Widgren 1999, 2000 and 2004). Indeed, the types of fixed technologies employed to allow continued sedentary agriculture in these areas are also those that are currently endorsed by various authorities as appropriate methods of increasing or maintaining agricultural production whilst conserving resources; an argument that is often presented as having particular contemporary relevance given that water sources and soils will be subjected to increasing demands if global changes to the climate (Low 2005; Paavola 2004) and population (for example Evans 1998) are even close to those predicted. However, as was briefly summarised in the introduction and will be discussed in more detail here, the argument that examples of African intensive agriculture may act as paradigms for sustainable land-use is at risk of becoming somewhat circular, relying as it does on assumptions as to the ages of the cited systems.

That the majority of the agronomies to be discussed below are precolonial in origin is attested to by written, oral or archaeological sources. However, in most instances the dates at which intensification began are not known, and neither are there detailed data as to how these systems developed and expanded or, in some instances, declined. In the absence of this detail it is clearly very difficult to assert that a system is sustainable, especially if it is not known whether the strategy of resource use has changed through time, or whether the population levels supported by the system have fluctuated. If sustainable, then sustainable for how long; sustainable under what conditions, and sustainable for what size of population? Although attempts have been made to gain access to this kind of information through oral testimony and tradition, these techniques have tended to produce good data only for the more recent past (for example Soper 1983 and Tagseth 2002 and 2004) but have struggled to achieve definitive results in terms of the dates of systemic inception. Indeed, since in the cases of Marakwet, Kenya (Soper 1983, Moore 1983) and Koyfar, Nigeria (Netting 1993) the current inhabitants of the area state that their ancestors are not responsible for the construction of all of the features now used, it is clear that historiographical enquiries alone will not provide this vital information. Archaeological studies may, therefore, be the most appropriate means of gaining access to this missing contextual data, especially given that the level of landscape modification evidenced in these areas means that the archaeological visibility of agricultural development is likely to be high.

There are, however, problems with such an assumption. The first of these relates to the archaeological invisibility of local categories of thought and 'values' as discussed in the preceding chapter, the importance of which will be demonstrated below by more specific reference to the historiography and ethnography of African agricultural communities. A second problem concerns the issue of potential bias within the archaeological record caused by the destruction or disturbance of earlier features by later cultivation (Farrington 1985b). Thirdly, and linking the two previous concerns, is the additional issue of how intensive agricultural systems are recognised on the basis of archaeological remains; a further bias of preservation that has meant that archaeologists have tended to employ models of agricultural intensification to infer social changes from technological developments, rather than use archaeological data to question the validity of the theoretical frameworks (Morrison 1994, 1996 and Leach 1999). Indeed, in the absence of detailed information regarding the social and economic histories of the communities to be discussed here, it may be more reasonable to regard many of these agronomies not as intensive, but as simply specialised (Sutton 1985 and 1989b).

Definitions of intensive agriculture

As will be discussed in this, and subsequent sections, there has been considerable debate as to the definition of 'agricultural intensification', with several schemas proposed for the possible trajectories of agrarian development (for example, Boserup 1965, Brookfield 1972, 1984, Farrington 1985a and 1985b, Geertz 1963, Kirch 1994, Leach 1999, Morrison 1994, 1996 and Netting 1993). Indeed, Brookfield (*Comments* upon Leach 1999: 325) has suggested that if the term 'intensification' cannot be "expunged from a literature in which it is so deeply embedded, it would be far better to downgrade it to a proper, and essentially minor, place in efforts better to understand and explain agricultural transformation". This point is well taken, and corresponds with the view expressed here that single explanatory frameworks often fail to take account of local adaptations and have poor track records as regards their attempted application in development planning. Nevertheless, since the current study is not concerned with attempts to create general models of agricultural intensification, the term 'intensive' can be employed here very broadly to encompass a variety of agricultural processes. 'Intensive agriculture' is thus defined simply as labour intensive (Adams 2004: 133; but see also the discussion below) and, following Widgren and Sutton (2004), is used primarily to distinguish those African agronomies that support relatively high population densities from more extensive forms of agriculture that sustain smaller communities per unit of land. This is not to say that population increases were necessarily the catalyst for intensification as has been most famously suggested by Boserup (1965 and 1981), and neither does it imply that the central control of a population is a prerequisite for the construction of extensive irrigation or terrace systems as proposed by Wittfogel (1957). Clearly, however, whilst population density can function as a relatively non-contentious criterion in the case of extant communities, establishing population levels in the past is a more difficult proposition.

An alternative, and no doubt more exact, definition of intensification is one based on agricultural output or, more precisely, increased yields measured against constant land (Netting 1993 citing Boserup 1965 and 1981). Such a definition has the advantage that it limits the number of variables, measures outcome rather than intention, and includes a temporal element. However, in the context of the current study it is perhaps too limiting as it would require good records of output over long periods. Whilst often quite detailed accounts of this kind are available for the colonial period in the form of District Commissioner's and Agricultural Officer's reports (see, for example, Anderson 1988 and Little 1992 for Baringo; Adams 1996 for Marakwet; Thornton and Rounce 1936 for Ukara Island), and it may be possible to estimate yields from the accounts of early European travellers (for example Koponen 1988: 297-8, 301), in the majority of cases agricultural output for the precolonial past can only be surmised on the basis of proxies. Evidence of high population densities, of the storage of surpluses, or of production for trade may, therefore, be seen as indicative of high yields and would broadly satisfy an output-based classification of intensive agriculture if this evidence were associated with the cultivation of permanent fields.

As Morrison (1996: 587) highlights, however, intensification of production rarely occurs without some degree of expansion of the area under cultivation and, as such, rigid adherence to a definition that stipulates land as a constant may be too restrictive or even misleading. Similarly, reliance on output as the sole indicator of intensification assumes that the ultimate aim is to maximise production. For example, it is entirely within the tenets of Boserup's (1965) thesis that a household or community may respond to falling yields by increasing their labour inputs. The intention in such a situation need not necessarily be to increase output, but may instead simply reflect the need to maintain former levels of subsistence. This would represent an extreme example of what Geertz (1963) has termed 'agricultural involution' whereby the relative efficiency of labour falls as more work is required to maintain or increase yields. Under an output-based definition of intensive agriculture this process might not qualify as intensification, yet it seems probable that it would feel like it to the individuals involved.

It has been suggested, therefore, that it may be possible simply to invert the input-output equation and thus define, or at least identify, intensification on the basis of increased inputs of labour. As will be returned to below, this is a formula that is attractive to archaeologists and historical geographers because it means that intensive agriculture can be identified as having existed in any location where there is evidence of substantial expenditure of physical effort, as demonstrated by the presence of features such as terraces, raised beds or irrigation canals (Farrington 1985b, Morrison 1994, 1996 and Leach 1999). Such features can thus be viewed as indices of yields in excess of those achievable by expansive agriculture on the grounds that the need or desire for higher outputs must have been the stimulus for increased inputs. One possible objection to such an assumption is to note that evidence of an attempt to intensify production does not constitute evidence of successful intensification (Netting 1993 citing Burton and White 1984 and Bradley et al. 1990). This is no doubt true, but merely suggests that evidence of increased production would need to be sought in individual cases by reference to one or more of the proxies outlined above.

With certain caveats then, the term 'intensive agriculture' is used here to refer to agrarian systems that are more labour intensive than expansive forms of arable or pastoral production. As with the alternative definitions, the term is employed only in reference to sedentary agriculture where land is farmed continuously, and is thus not applied to systems that are characterised by successive periods of short-term occupation and abandonment. In deference to Morrison's (1996) observation that attempts to intensify production may involve some expansion of the community's resource-base, this broad definition is intended to include agricultural societies that can be seen to have continuously or periodically extended their systems of cultivation. This definition thus encompasses intensification based on simply increasing the input of labour into a pre-existing system (see, for example, Geertz 1963), and the process of improving or maintaining yields through the introduction or extension of technologies or techniques (for example Boserup 1965), since the latter also requires the expenditure of additional labour. Although it is possible to draw a distinction between these two processes by noting that the former requires ongoing commitments of labour whilst the latter may comprise activities such as landscape modifications that only need additional work during the construction phase (Kirch 1994), to do so is to make assumptions as to the timeframe of construction and the labour requirements of maintenance (Doolittle 2000; see also Doolittle 1984 quoted below). The notion that intensification can also be defined as an increase in production per unit of labour is thus not employed here, though it should be noted that such an amendment would be necessary in situations where production can be mechanised, or where infrastructure developments can be reasonably regarded as investments.

Under such a definition, intensification of production could comprise any activity designed to increase the supply of, quality of, or control over, a given resource or group of resources without necessitating the abandonment of the current area of exploitation. Such activities include the construction of irrigation features to either increase or limit the supply of water; the construction of terraces to level land, increase soil depth, improve drainage, control soil temperature or limit erosion; the application of manure or compost to improve soil fertility; the shortening of fallows; and the rotation, staggered sowing, ratooning, transplanting or interplanting of crops. Moreover, this broad definition would encompass processes of agricultural development that might be described more specifically as specialisation (for example Sutton 1985), diversification (Bayliss-Smith 1982; Farrington 1985b; Morrison 1994 and 1996 citing Kaiser and Voytek 1983), innovation (Brookfield 1984) or risk mitigation (for example Anderson 1989). If applied rigidly, however, a labour-based definition would not include intensification through the introduction of traction or mechanisation (though this is arguably merely the substitution of one form of labour for another), and may not include the development or importation of crops which either produce higher yields or that place fewer demands on other resources (i.e. are tolerant of drought, inundation, pests, weeds or particular soil conditions). Although the first of these exclusions is clearly not a problem in terms of the current study, the second would represent a serious limitation if it could not be seen archaeologically. These caveats notwithstanding, a definition of intensification based on labour is preferred here because it avoids potential misunderstandings that may result from the use of terms with neo-classical economic implications.

Widgren (1999, 2000 and 2004), for example, has suggested that the concept of 'landesque capital' is useful in reference to African intensive agriculture, with the term itself defined as investments "on land (and vegetation) that reach beyond the immediate needs of the coming cropping season" (Widgren 1999: 5 and 2004: 7 referencing Brookfield 1984 and Blaikie and Brookfield 1987; though see also Widgren forthcoming who notes the use of the term by Sen 1960 and Marx's use of the similar concept of *la terre-capital* in volume three of *Capital*). Such a definition, however, would include the periodic expenditure of labour required in swidden cultivation, and raises questions as to the validity of concepts such as 'capital' and 'investment' in local notions of agriculture. This last point is acknowledged, albeit tangentially, by Widgren (2004), who notes that the concept might be seen as under emphasising the extent to which the ongoing maintenance requirements of 'landesque capital' could render the investment analogy inappropriate because "construction, cultivation and maintenance are inextricably linked activities" (Doolittle 1984: 135 cited in Widgren 2004:7). In short, something is not an investment for tomorrow if it is also a necessity for today.

The term 'labour', of course, could be seen as producing similar problems, since, as Polanyi has argued "labour is only another name for a human activity which goes with life itself" (1957: 72), and that consequently it might be inappropriate to attempt to separate effort spent in the maintenance of social relationships from 'work' undertaken for agricultural production (see also Godelier 1978). However, the concern at this stage is not how labour is viewed within different societies, but rather with the recognition that labour is the one factor in equations of agricultural intensification that can be readily mobilised. That is to say, on the (admittedly sizeable) assumption that other necessary agricultural resources are not already being employed at their full productive capacity and that an individual has access to these resources, inputs of labour can be increased to intensify production. As noted above, this model would not account for intensification based on the development or adoption of new crop 'technologies' (genetic innovation – Kirch 1994), because intensification on the basis of new plants would require either time for the development of the crop variant, or access to, and knowledge of, the imported cultigens. In contrast, where the speed of innovation is not constrained by the growth cycle of crops, as with the development of other agricultural technologies such as terraces or irrigation features, the only limitation other than labour in the 'perfect market' envisaged above, is an understanding of the techniques of construction, management and use. Or, to put it another way, the only constraints to technologically-based intensification is access to labour and to the knowledge of how it can be applied (i.e. the 'labour' and 'skills' of Brookfield's tripartite equation of 'capital, labour and skills – 1972: 31).

One of the questions to be addressed here, therefore, is whether archaeological investigations of examples of African intensive agriculture can be employed to gain access to this technical knowledge by studying the remains of features within intensively cultivated landscapes. In essence such an approach would be an attempt to reverse engineer local technical knowledge by starting with the physical remains of intensive agriculture, and working back to the local knowledge that produced it. Indeed, if possible, this process would seem to be worthwhile even in those areas where locally developed intensive agriculture continues to be practised, since only then could an assessment of the longevity of these activities be made (Niemeijer 1996). It should be clear from the discussion presented in the preceding chapter, however, that archaeological data will only provide a partial picture, and that ethnographic, historiographic and agronomic information will be needed to supply analogies of extremely pertinent social factors such as systems of resource allocation, labour organisation and cropping strategies. Thus, whilst the previous chapter outlined problems with the archaeological visibility of intangible forms of local knowledge in general terms, this chapter will illustrate specific examples of how local institutions and categories of thought affect models of African intensive agriculture. The intention here, therefore, is to highlight those areas where archaeological investigations can add contextual detail to the history of local approaches to resource exploitation. To do so is to simultaneously point out the weaknesses of archaeological enquiries in studies of this kind, yet such an appraisal is necessary if a realistic assessment of archaeology's potential to contribute to this area of research is to be presented. Indeed it can be argued that issues of archaeological visibility have thus far framed the debate regarding prehistoric/precolonial intensive agriculture in Africa and elsewhere. The common themes relating to intensive agriculture will therefore be summarised, before examining a series of case studies that illustrate the dynamic and complex nature of precolonial African agronomies.

Themes in the study of intensive agriculture

The issue that underlies any attempt to reconstruct agricultural history via the examination of former areas of cultivation is the likelihood that evidence of earlier farming practices will have been substantially disturbed by subsequent decades, centuries or millennia of agricultural production. This bias of preservation is noted by Farrington (1985b: 5), who argues that where survival of archaeological evidence of agricultural land-use exists, this is likely to be in marginal areas that are either "too wet, too dry or too steep" to have prompted later populations to rework, and hence destroy, the earlier field systems. The apparent marginality of these sites commonly leads, in turn, to one or more of several further generalisations. Perhaps the most common of these is to view such sites as isolated, and hence ill equipped to draw on alternative resources or the help of neighbouring communities in times of stress (see, for example, Grove and Sutton 1989; but see also the discussion of Sutton's later work below for a qualification of this view). As will be argued here, whilst isolation cannot be ruled out as a factor in all instances, ethnographic data is strongly suggestive that such specialised sedentary forms of land management rarely exist without some degree of reciprocal support from neighbouring communities whose economies are based on differing, or complementary, modes of resource exploitation.

Related to the interconnected generalisations of marginality and isolation is a further common supposition that visually impressive archaeological remains such as stone-built terraces and extensive systems of irrigation canals necessarily represent intensive agricultural land-use. Although where this issue was introduced above it was argued that the term is useful as a broad classification, problems arise when it is assumed that such sites can be explained by reference to general theories of agricultural intensification. Undoubtedly the most commonly cited of these is Boserup's (1965) *The Conditions of Agricultural Growth*, which can be crudely summarised as arguing that intensification occurs as a response to increases in population density where there is a scarcity of land into which the community can expand or fragment. According to this model a community (or on a smaller scale a household) may initially respond to a need for higher yields by increasing the frequency of cropping, thus shortening periods of fallow. However, such a strategy will inevitably lead to soil exhaustion unless other techniques or technologies are developed to counteract this effect.

Such an hypothesis has a clear attraction for archaeologists since it suggests that physical remains associated with agriculture can be easily equated with intensification, and offers an explanation of why these changes may have taken place (Morrison 1996). Irrigation canals can thus be seen as evidence of 'investment' to increase yields and might also be interpreted as an indication of constraints on expansion. Terraces may be viewed in the same terms, but may be regarded additionally as a response to soil exhaustion or erosion. The demarcation of fields may be interpreted as evidence of land tenure, or even as an indication of an "intensive short fallow regime" (Kirch 1994: 234, also cited in Leach 1999: 315). Moreover, even in areas that contain evidence of considerable earlier 'investment', abandonment can still be explained in terms of either resource degradation to the point of systemic collapse, or as a result of the removal of the constraints that formerly limited migration. In short: "The archaeological appeal of such models is obvious, since painstakingly constructed inferences about one aspect of economic organisation can then blossom into a full-blown picture of the past" (Morrison 1996: 585).

Indeed, the model seems almost tailor-made for archaeologists in that it offers a motive for technological innovation and, moreover, predicts that the success of this innovation may lead to further population rises and thus further increases in technological or social complexity. Without this motivation, explanations of economic and social development are obliged to treat technological innovations as if these were Darwinian mutations: spontaneously developed and only passed on if they offered advantages to those who possessed them. Thus technology-led models show a tendency towards diffusionism, with innovations spreading outwards from their point of origin. Such schemas, however, require an assumption that communities will always seek to maximise production (see below), and are thus at a loss to explain why societies undergo these transformations at different rates or, in some cases, resist them entirely (Netting 1993, for instance, cites Hahn 1919 and Childe 1951 as examples of this view, but see also Goody 1971). Proponents of Boserup therefore regard her as a debunker of this kind of teleological thinking, highlighting that her model provides the incentive behind social and technical transformations; allows for both intensification and disintensification, and avoids environmental determinism (Cohen 1977, Johnson and Earle 1987 and Netting 1993). Moreover, by arguing for the universality of concepts such as scarcity and human rationality, aspects of the Boserupian model can be employed to account for a range of different subsistence strategies, and thus counter the view that modern hunter-gatherers or swidden agriculturalists are 'primitive', 'backward' or irrationally resistant to change, on the grounds that these communities had simply not faced the crisis of population increases or land scarcity that would prompt them to give up subsistence strategies that required relatively small inputs of labour (for example Sahlins 1974, though this may be regarded as an essentially political move on Sahlins' part: note his rejection of maximising rationality as a universal in Sahlins 1976).

Whilst there are numerous examples of detailed case studies that support the tenets of Boserup's schema (for example Gleave and White 1969; Netting 1968 and 1993, Turner, Hyden and Kates 1993), and others that broadly endorse the model with some qualification (for example Stone 1993 and 1996; Conelly 1994; Conelly and Chaiken 2000), there is also a growing body of cogent critiques that demonstrate its inapplicability to specific case studies, several of which will be reviewed below. The intention here, however, is not to dismiss the insights of the population-led model, but rather to highlight the need to test its assumptions by examining the histories of areas of intensive agriculture in Africa, and to examine the feasibility of employing archaeological techniques to do so. For example, even from the brief summary presented thus far, it is clear that in the terms of the Boserupian model, abandoned intensive agricultural sites such as Engaruka in Tanzania or Nyanga in Zimbabwe may have been deserted either willingly or reluctantly. In other words, they may represent the physical remains of well adapted and sustainable agronomies, or else they might attest to the inability of the communities that built them to stave off a Malthusian collapse (Malthus 1985 [1798]). Arguments in support of these two abandonment hypotheses have been presented for both sites, and serve to illustrate a further common theme in discussions of African intensive agriculture.

The so-called 'siege hypothesis' (Koponen 1988 and Netting 1993 both citing Gourou 1966; Wigren 2004 citing Gourou 1991) or circumscription model (Morrison 1994 citing Carneiro 1970) has clear parallels with Boserup's thinking, and indeed complements the population-led schema since it recognises that land scarcity might result from hostile relationships with neighbouring communities. In common with Boserup, Gourou sees social factors as more significant than environmental conditions in accounting for the development of resource exploitation strategies, and explains agricultural intensification as a response to an inability to continue with more expansive forms of agriculture. As mentioned previously, several of the intensive agricultural areas to be discussed here have been explained in these terms, including Nyanga (Summers 1958), Engaruka (Sutton 1978, though this interpretation has subsequently been revised), Iraqw, Tanzania (Gourou 1991 cited by Widgren 2004; see also Börjeson 2004: 70), South Pare, Tanzania (Håkansson 1995), Koyfar, Nigeria (Netting 1993 citing his own articles of 1973 and 1974) and Arusha, Meru and Kilimanjaro in Tanzania (Southall 1961 also cited by Börjeson 2004). Although some of these writers mention physical characteristics of settlements in support of the siege hypothesis such as possible defensive structures or nucleated village sites (Sutton 1978; Netting 1993), for the main part the interpretation of containment is either assumed on the basis of 'remoteness' of location, or is inferred from sources that attest to possible threats posed by other communities, for example Maasai expansion (Southall 1961; Sutton 1978) or the slave trade (Koponen 1988: 241; Robertshaw 2005). The siege hypothesis thus requires qualification for individual areas, but does at least highlight the need to take a broad spatial as well as temporal perspective which acknowledges that changes at the local level may be a response to wider regional or even international developments.

Until recently, a further generalisation has been prevalent in the archaeological literature on intensive agriculture. This has been the tendency to apply neo-formalist economic models that assume the communities that built and maintained these agronomies were comprised of rational, maximising individuals. In so doing, theories relating to the adoption and abandonment of associated practices have tended towards a functional 'crisis' led approach along the lines of the broad model suggested by Sahlins (1974), which itself shows clear parallels with Boserup (1965). Again, this is an issue that has been raised above as it is inalienable from several of the themes summarised thus far. Nevertheless, the subject deserves specific attention since it highlights the need to attempt to give adequate emphasis to local institutions. As will be demonstrated below, these institutions can be viewed at a series of scales that in some cases may lend themselves to economic analyses that allow for communal ownership or local sumptuary regulations (for example Potkanski and Adams 1998). Nevertheless, even at their simplest, an appreciation of the complexities of local practices such as systems of resource allocation (for example Adams, Potkanski and Sutton 1994, Adams Watson and Mutiso 1997, and Fleuret 1985), serves to illustrate the difficulties inherent in any attempt to produce substantive economic models. Indeed, the realisation that these systems of allocation are also subject to complex and potentially rapid changes (Potkanski and Adams 1998), is not conducive to an optimistic view of the potential for archaeological reconstruction. Yet these institutions are themselves 'embedded' (Polanyi 1957, 1968) within broader systems of beliefs and values (Fleuret 1985; Sheridan 2002; Watson 1999 and 2004). The stance taken here, therefore, is to attempt to give adequate weight to a more substantive, institutional, economic approach, by arguing that metaphysically/cosmologically informed decisions are likely to have played an important role in agricultural decision making, regardless of whether or not these produced functional effects, or were the result of determinable 'causative' processes. Arguments of this sort are, naturally, also related to the issue of preservation: archaeologists rarely have access to the data necessary to examine metaphysical factors. As such, extant, or recently extant examples of analogous systems will be employed to add detail to the archaeological enquiries. The intention thereafter is to assess the feasibility of employing the archaeological data to add temporal depth to our understanding of these contemporary, or historically studied, communities.

Among the local conceptions that will need to be considered are how communities perceive(d) the environment, weather and/or climate. This is an issue that has received some attention recently as it is tied to notions of sustainability and conservation, and thus also to questions of climate change and environmental degradation. Archaeologists have tended to remain justifiably reticent on this subject, but a reasonable desire to avoid unnecessary speculation does not mean that the discipline can ignore the extent to which local agricultural decisions rely on expectations of how the environment will behave. The flip-side of such a discussion is to acknowledge that regardless of how the environment is conceptualised locally, communities are nevertheless faced with the need to cope with changes in environmental circumstances and fluctuations of weather which may include long-term climatic trends.

Indeed, the possible importance of environmental factors has been highlighted in discussions concerning the site that forms the primary case study here, with Westerberg (2002) noting that Engaruka's period of occupation broadly corresponds with the global climatic shift known as the 'Little Ice Age', and that, in eastern Africa, this event is associated with increased rainfall (Verschuren, Laird and Cumming 2000). Similarly, Sutton (for example 1978; 2000 [1998]) has long argued that abandonment of the site may be associated with a decline in the flows of the rivers that formerly fed the irrigation system, though it is noted that this decline may have resulted from deforestation of the river catchments, rather than as a consequence of climate change. Environmental factors, whether local or global, thus form another significant theme, and indeed the prevalence of the view that the cause of abandonment of agricultural sites can be attributed to changes in ecology has been noted by Farrington (1985b), particularly in reference to the contributions to the two volumes under his editorship (Farrington 1985a).

The final generalisation of relevance here is one that perhaps draws together the themes discussed thus far. This is the tendency to regard precolonial economies as expressions of either a 'primitive' or 'merrie' Africa. Both terms were coined by Hopkins (1973) to refer to the two extremes of a conceptual continuum, one of which sees precolonial Africa as characterised by unchanging societies locked into timeless customs and traditions and thus constrained by lack of innovation, whilst the other views these same communities as operating simple but effective economies that were well adapted to their environments, but which were nevertheless unable to cope with the devastating and exploitative impact of European colonialism. Although both of these extremes were presented as myths, they have clear parallels in debates surrounding the promotion of development initiatives via either 'modernisation' or through 'indigenous knowledge' (Richards 1993; Woodhouse, Bernstein and Hulme 2000b), and have received particular attention in eastern Africa, prompted, in part, by the views expressed by Kjekshus (1977) and Iliffe (1979), which have been regarded respectively as supporting a 'merrie' or 'primitive' perspective (Koponen 1988: 21-2; McCann 1999a). These two stereotypes still need to be challenged therefore, as does the assumption that is implicit in both, that the colonial encounter can be employed as a catch-all explanation for the abandonment or dramatic adaptation of indigenously developed practices. An alternative approach, as has been argued by Koponen (1988) and others, is to regard the colonial situation as merely the latest stage in an historical process with much earlier precedents. Yet Koponen has himself been accused of being an apologist for Kjekshus (McCann 1999a) and criticised for failing to add sufficient contextual detail to the sources he cites (Waller 1991). For many of the areas of intensive agriculture to be discussed here this detail is now available, but in a sense this body of data creates a further dilemma in that it both demonstrates the complexity of African agriculture, and in doing so calls into question the extent to which African agronomies can be understood historically. Nevertheless, by examining broad historical perspectives, the current study hopes to help situate the archaeological and ethnographic case studies, which themselves suggest that African agricultural practices were never static but, in contrast, were continually adapted to changing conditions. In this light, abandonment of agronomic structures, regardless of how much labour they may have originally taken to construct, need not be seen as a 'failure' of that mode of resource use, but rather, as simply a stage in an ongoing process of communities seeking to manipulate those factors that they regarded as offering the greatest comparative advantage at any given time. Such an approach requires a critical appraisal of the general themes and models summarised above. Before offering this critique, however, it is necessary to outline a brief gazetteer of the archaeological, historical and contemporary sites that form the current case study.

A 'site' gazetteer and history of African intensive agriculture

The following summary of intensive agriculture in sub-Saharan Africa makes no pretence to being exhaustive and indeed, in keeping with the aims and case study of the current project is biased towards eastern Africa and places specific emphasis on areas that employ permanent or semi-permanent modifications to the landscape, as these are the features most susceptible to archaeological investigation. Following previous gazetteers presented by Sutton (1985) and Grove and Sutton (1989), therefore, this summary might be better characterised as an overview of terraced and irrigated agricultural sites, though areas that employ labour intensive soil conservation techniques such as ridging, manuring or 'pit cultivation' will also be mentioned[6]. This bias is perhaps most obvious in terms of flood water farming whether from rising floods (*crue*), flood-recession (*décrue*) or residual soil moisture, since these techniques, whilst clearly intensive in terms of labour, may leave very limited traces in the form of definable archaeological features (for example Connah 1981 and 1985). Although somewhat beyond the geographical and historical remit of the current study, undoubtedly the most famous example of flood recession farming in Africa is that operated on the Nile in ancient Egypt. It would be something of an understatement, therefore, to say that systems of this sort are extremely interesting archaeologically, but they remain, nevertheless, outside the scope of this project, and will thus be introduced but not discussed in detail. Similarly, although irrigation and terrace systems of note exist in various locations in north Africa (see for example Ait Hamza 1996; Hill and Woodland 2003; Chaker, el Abbassi and Laouina 1996) these will not form part of the following gazetteer.

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[6] Although there are several earlier discussions and gazetteers of African intensive agricultural practices, the accuracy of these studies has been questioned (see, for example, Sutton 1969: 1-3 citing Huntingford 1933, Summers 1958, Davidson 1959, Murdock 1959, Cole 1963 and Allan 1965).

West Africa

In terms of terraces, and in particular terraces employing dry-stone walling, Grove and Sutton (1989: 119) note the presence of sites throughout northern Cameroon, as well as occasional terraced areas in the Volta and Upper Niger basins, but draw specific attention to several clusters of known sites in the Nigerian savannah belt. Grove and Sutton (1989: 120) depict 21 such areas on a map of Nigeria including the extensive stone terraces at Tula and the comparatively well studied area of Koyfar on the Jos Plateau (Netting 1968 and 1993, Stone 1993 and 1996). Outside savannah areas, the sites of Nsukka and Maku, located in the forested region to the north-east of the Niger delta (Grove and Sutton 1989 citing Floyd 1964, Gunn 1953 and Conant 1960) are also depicted. The use of cattle manure as fertiliser is considered to be common in West Africa, but is not practised in all instances, whilst the combined use of terraces with artificial canal irrigation is not known (Adams 1989; Sutton 1985 citing Netting 1968 and Grove 1951). Groundwater irrigation using wells is widespread, but examples of the use of mechanical lifting devices are rare. The ox powered *dallou* from the Air Mountains of central Niger is therefore worthy of note (Adams 1989 citing Roger 1984).

The cultivation of grain crops utilising flood waters is a fairly common practice in lowland and river delta areas (Adams 1989), examples of which include systems operated on the Niger, Benue, Sokoto, Hedejia-Jama' and Senegal rivers (Adams 1986a and 1989 citing Adeniyi 1973, Watt 1981 and Boutillier and Schmitz 1987; Connah 1985 citing Scudder 1980; Swindell and Iliya 1989). Of these, the *décrue* cultivation employed around the inland Niger delta in Mali (Adams 1989 citing Gallais and Harlan and Pasquereau 1969) is perhaps worthy of additional comment, both for its potential age (Macintosh and Macintosh 1980 and 1993) and for the ways in which the floodplain is used by different groups operating complementary modes of resource exploitation before, during and after the annual inundation (Sundstrom 1972). The flood recession farming system operated in the *Firki* plains to the west of lake Chad in Nigeria also combines arable production with the keeping of stock, and aptly illustrates the issue of the current project's bias towards sites that employ long-lived agricultural features, since the system requires the yearly repair or reconstruction of low earth bunds designed to retain water for cultivation (Connah 1981 and 1985). Nevertheless, on the basis of evidence recovered from associated settlements, Connah suggests the cultivation of sorghum by *décrue* techniques in this area may have a history extending back to the early first millennium AD.

In addition to the irrigation techniques practised in major inland floodplains, both *crue* and swamp cultivation are employed for rice production in northern Sierra Leone, with swamp cultivation also undertaken in various places along the Niger (Adams 1989 and Andah 1993, both citing Richards 1983, 1985 and 1986). Moreover, on the west African coast, there are several examples of irrigation systems based on the production of rice, of which perhaps the best known is that operated by the Diola in Guinea-Bissau, who utilise areas of mangrove swamp in tidal estuaries via a combination of dams, field ridges, rice transplantation and even desalination, and appear to have done so since prior to European contact (Adams 1989 and Andah 1993 both citing Linares 1981). An analogous system of nineteenth century rice cultivation based on land reclaimed from the Casamance estuary is also cited by Andah (1993: 245).

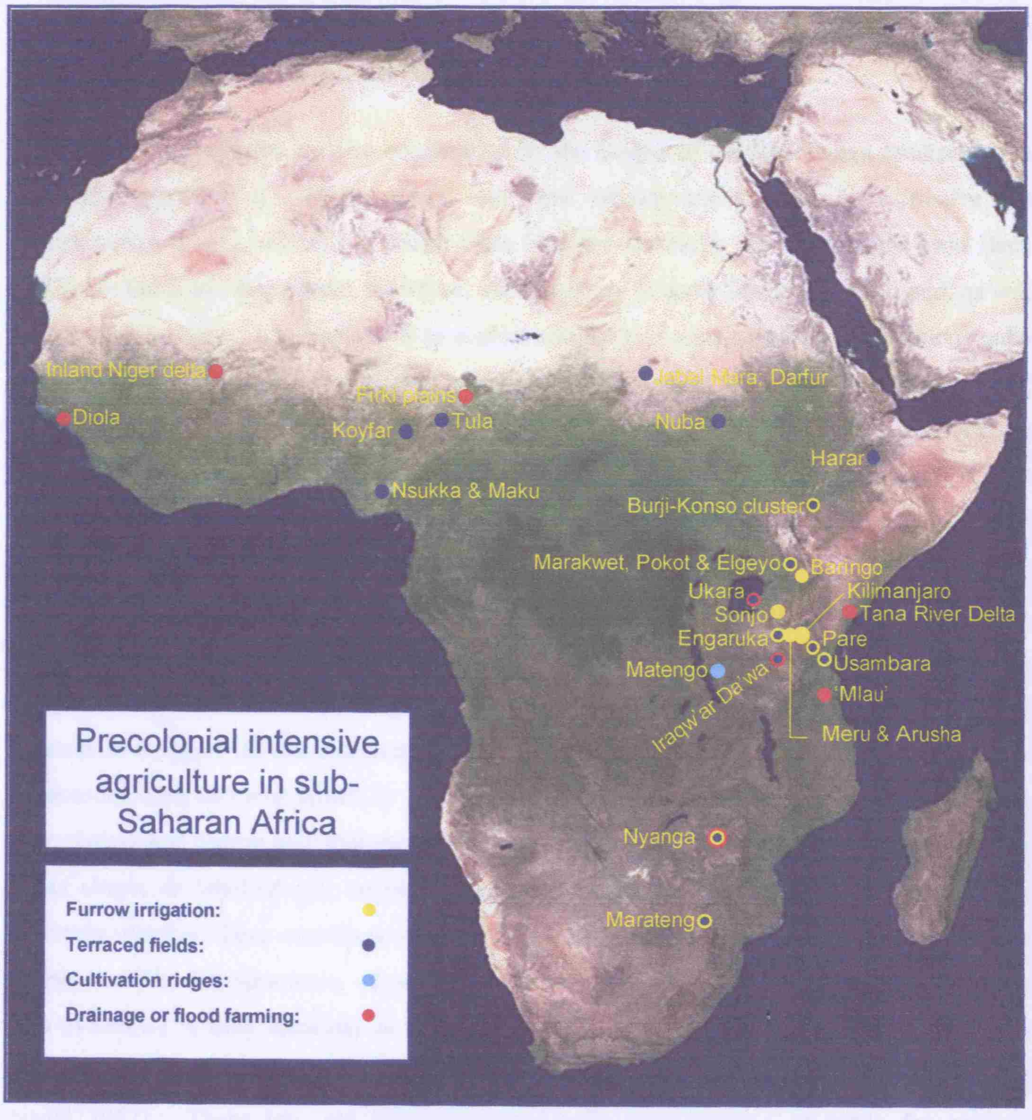

Figure 3.1: Precolonial intensive agriculture in sub-Saharan Africa showing sites mentioned in the text.

In general, therefore, instances of irrigated agriculture in west Africa are better dated than the terrace systems. Indeed, with one exception, all the cases of terraced agriculture cited by Sutton (1985) and Grove and Sutton (1989) were initially identified on the basis of observations of cultivation, rather than through the recognition of abandoned agricultural features. Of these cases, the majority continue to be farmed and might be assumed – largely through lack of evidence to the contrary – to have been constructed by the ancestors of the communities that now manage them (Sutton 1985; Grove and Sutton 1989; Netting 1968 and 1993). This assumption, however, owes much to the perception of these areas as being remote and isolated 'archaic' survivals; a perception that is reinforced by the maintenance of local languages and by the occupation of (or at least continuance of settlement within) discrete hill locations that appear in marked contrast to the expansive savannah cultivation of the Hausa (Sutton 1985 and Grove and Sutton 1989).

Stone bounded terraces are also constructed by the Dogon of the Bandiagara escarpment in Mali (Kassogué et al. 1996), where field and terrace construction may involve the transportation of soil, with the resultant plots irrigated manually when necessary (van Beek 1993). In terms of labour input, therefore, the agronomy is undoubtedly intensive and, as will be returned to below, has been cited as a clear example of agricultural intensification under siege conditions (Kassogué et al. 1996). Crops include sorghum, millets, beans, fonio, maize, onions and tobacco. By association with settlement sites the agricultural system would seem to have its roots in the fifteenth century AD.

North-east Africa: Sudan, Ethiopia and Somalia

In Sudan, extensive terraced agriculture is observable on the Darfur hills, most notably at Jebel Marra (Sutton 1985 citing Paterson 1948). The use of animal manure is extensive in this area, as is the construction of irrigation features, although the main terraced areas are not themselves irrigated (Grove and Sutton 1989 citing Crawford 1953 and Patterson 1948). The terraces are built and maintained by the Fur and, indeed, large areas are still cultivated in this way. Grove and Sutton note that there are examples of abandoned terraces, particularly in the upper slopes of Jebel Marra, but they conclude that there is currently insufficient data to ascertain whether these constitute remains from an earlier system, or are simply disused elements of the Fur structures. Traces of field-systems and their associated settlements are also evidenced in hilly locations to the east of Darfur within Kordofan, including extensive areas of stone-built terraces in the Nuba hills (Sutton and Grove 1989 and Sutton 1985 citing Nadel 1947). These too, are often combined with stall feeding of cattle for manure accumulation.

As regards irrigation, the area of modern Sudan obviously encompasses much of the middle Nile where there is a long history of both flood recession farming and the use of water lifting devices, and indeed it has been suggested that these two categories of irrigation can be used to characterise arable areas adjacent to the Nile (Trigger 1965 cited by Connah 1987: 30-31) as either *Seluka* land (that which is periodically inundated), *shaduf* land (that which can be irrigated by mechanically lifting water up to three metres) or *saqai* land (areas that require water to be lifted up to eight metres and are thus characterised by the use of animal powered water wheels). Within Sudan the main stretch of *seluka* land lies on either side of the Dongola Reach between the Fourth and Third Cataracts, and is the only area of the middle Nile to be flooded annually. Like the Lower Nile, it also contains numerous overflow basins that extend the area capable of being irrigated by flood waters. These include the Kerma basin which, together with the wide floodplain to the south of the Third Cataract, acted as the arable resource base for the polity of Kerma in the early second millennium BC (Connah 1987 citing Adams 1977).

Further south, but still within the Dongola Reach, a similar case can be made for the development of a power base for the Kingdom of Kush at Napata during the ninth century BC (Connah 1987 citing Haycock 1968 and Adams 1977). Meroë, the apparent successor of Napata as a political centre of Kush between approximately the fourth century BC and the fourth century AD, is also located in an area with potential for irrigated farming of fertile alluvial soils, although in this period the economy of the area appears to have also placed considerable emphasis on animal husbandry (Connah 1987 citing Adams 1977 and Ali 1972). Nevertheless, sorghum seems to have been grown as a subsistence crop, with the prevalence within archaeological assemblages of the *qudas* pottery vessel attesting to the importance of the *saqia* water wheel (Connah 1987 citing Adams 1977). Indeed, Connah (1987: 30, 46 and 53) has argued that the reoccupation of Lower Nubia by the Meroitic state in the second and third centuries AD may have been enabled by the introduction of the ox powered water wheel, as this made it possible to irrigate more land than had been achievable using the human operated *shaduf*. The *shaduf* itself, however, has a considerably longer history of use in the middle Nile, with the concept apparently having been imported from Egypt at some time during the New Kingdom period of the mid to late first millennium BC (Connah 87: 59). Thus, whilst the early adoption of irrigation technology on the middle Nile is somewhat outside the current study's main area of interest, and owes much to political and technological developments further north, it nevertheless attests to the longevity of such practices by what might be termed 'indigenous' and 'complex' African societies.

Indigenously developed intensive agriculture, as evidenced by the presence of irrigation and terrace systems, also has a long history in Ethiopia. However, in the majority of cases the dates at which these technologies were first employed in given areas are not known. Kobishchanov's study of inscriptions and historical sources relating to Aksum in the northern highlands, for example, suggests that terraces, irrigation and ox-drawn ploughs were in use between the first and fourth centuries AD, though this conclusion has not been confirmed archaeologically (Connah 1987: 85 and Philipson 1993, both citing Kobishchanov 1979). The case for an early development of the plough has also been made on linguistic grounds, on the basis that the roots of Ethiopian Semitic languages probably derive from some form of cultural contact with south Arabia during the first millennium BC (Philipson 1993) or perhaps slightly earlier (Munro-Hay 1993), yet employ a vocabulary for cereal production and ploughing that displays earlier Cushitic roots (Connah 1987: 85 and Philipson 1993 both citing Simoons 1965 and Ehret 1979; Ehret 2002). Nevertheless, regardless of whether or not the plough was in use during the Aksumite period, Ethiopia is the southernmost area of Africa in which the plough was in use prior to European contact. Moreover, it would seem that, with or without plough-based agriculture, the area of Aksumite Ethiopia was at least self-sufficient in terms of grain (?wheat – see Philipson 1993: 348 and 357) as the mid-first century AD *Periplus of the Erythraean Sea* does not include grain in its list of imports, despite noting that this commodity was traded elsewhere on the east African coast (Philipson 1993 citing Casson 1989). Given that this source, together with physical archaeological evidence, indicates that Aksum could be reasonably seen as an urbanised polity by around this time, some degree of agricultural intensification can probably be assumed. However, on the grounds that the extent or nature of this intensification is presently unknown, Aksumite agriculture remains peripheral to the current study.

Terraces are, however, fairly widespread in the northern Ethiopian highlands and are also constructed extensively in highland areas in the east and south of the county, and include both stone-built and broader contour terraces (Amborn 1989; Ehret 2002; Grove and Sutton 1989; McCann 1999b; Sutton 1985). On the basis of linguistic evidence Ehret (2002) asserts that the construction of irrigation features predates the use of terraces in these areas, and concludes that ancestral 'Highland East Cushites' where probably practicing furrow irrigation "in the centuries around 2000 BCE" (ibid.: 129-130) and that "probably well before 1000 BCE the irrigation farmers of the southern Ethiopian Highlands increasingly turned to building stone-walled terraces" (ibid.: 131). As befits the introductory style of this text, Ehret does not offer explanatory detail but essentially argues that evidence of Highland East Cushitic linguistic influences among Ometa and Dullay speaking groups suggests that the use of irrigation, manuring and terraces in the southern highlands derives from earlier Cushitic practices and may have been is use for over three thousand years. As in the case of Aksum, however, such a conclusion has yet to be confirmed by physical archaeological evidence, and indeed oral historical sources from terrace and irrigation using groups in the southern highlands suggest that specific instances of irrigated and terraced agriculture were not in use until the Late Iron Age. Amborn (1989: 73 citing his own fieldwork and the published and unpublished work of Straube), for example, notes that genealogical evidence from Konso indicates that certain social and political institutions connected with agricultural production may have developed in the sixteenth century AD, suggesting that intensification at Konso predates this time. Although such a conclusion does not refute Ehret's long chronology, a Late Iron Age date for the adoption of intensive agriculture in this area appears to receive support from local oral traditions regarding agricultural practices (Grove and Sutton 1989; Hallpike 1970 and 1972; Sutton 1985 and Watson 2004). At present only very limited archaeological excavations have been carried out in this area, though recent excavations of an abandoned household and its associated refuse deposits in Konso demonstrate clear changes to the artefactual assemblage through time (Kimura 2004), though it is not currently possible to reliably relate this chronology to the surrounding field systems. The recovery of imported glass beads from throughout the depositional sequence within the refuse heaps indicate occupation during the latter half of the second millennium AD.

The terrace and irrigation systems operated by communities within what Amborn calls the Burji-Konso cluster employ a variety of different field types and terrace wall designs to take account of local conditions and topography (see Amborn 1989: 75-76 and fig. 2). Although only a small proportion of the cultivated landscape relies on perennial rivers, even the seasonal rain-fed fields employ water management features in the form of drainage gullies and gaps in the terrace walls, whilst the terraces themselves act to retain moisture. Similarly, rain-fed fields in areas flat enough not to require terracing are divided by earth and dry-stone ridges into rectangular plots of approximately three metres square, which act to channel water and allow it to seep in gradually (Amborn 1989: 74). In Dirisha, approximately 30 kilometres to the north of Konso, pits are excavated into the centre of terraces and lined with stones, thus serving a similar function whilst delivering water to crop roots (ibid. citing Kuls 1958). At higher altitudes above the arable zone, dams up to 12m high and sometimes more than 60m long (Hallpike 1972: 24) are constructed to create ponds for watering cattle. Water channels of the type referred to in the ethnographic, geographic and archàeological literature as 'furrows' (a term with different connotations as regards European agriculture, and potentially confusing from an engineering perspective – Adams 1989: 26) are also constructed. Typically less than one hundred metres long, though with some examples traversing more than a kilometre, these channels deliver seasonal river water to fields within basins in the valley sides, and in some instances do so via aqueducts or by passing the furrow through openings in intervening terrace walls (Amborn 1989: 76). Flash floods along the perennial and seasonal streams can be severe, and indeed Hallpike (1972: 25) mentions that men were 'often' killed by such events. Large dry-stone walls are thus constructed as flood defences (see Watson 2004: 59 figure 3.7).

The crops grown in the more intensively cultivated areas include cereals and legumes, usually interplanted. A combination of sorghum, beans, eleusine (finger millet) and cotton is considered by Amborn to be common, though a far larger range of crop resources was recorded by Hallpike (1970: 36-7; 1972: 22-3). In areas above 2000m ensete (*ensete edulis* – a cultivar unique to Ethiopia and sometimes referred to as the 'false banana') is grown, occasionally also in terraces, some of which include water management structures. This would appear, however, to be a recent development as Hallpike (1970: 37 and 39; 1972: 22) notes that the crop was not widely grown. The 'cabbage tree' (*moringa stenopetala*) is cultivated for its edible leaves and as a means to consolidate soil and thus limit erosion. Other indigenous trees and shrubs are encouraged within the cultivated area for use as cattle feed and as a source of green manure. Both cattle manure and household refuse are employed as fertiliser (Hallpike 1970, 1972; Amborn 1989 citing ibid. and Kuls 1958, Minker 1986, Straube 1963 and Sasse 1977). As Watson's (2004) observations of various forms of communal and reciprocal labour in Konso demonstrates, this system is not only clearly labour intensive, but is also still very much in use. Nevertheless, large parts of the agricultural landscape and numerous households have been abandoned (Hallpike 1972: 20 and Sutton 1985 citing ibid. and Murdock 1959), though whether this is evidence of a diminished population is also uncertain.

When compared to Konso, the terraces employed elsewhere in Ethiopia are less well known and have received less research attention. Of these, the contour terraces at the Harari escarpment in the eastern highlands are perhaps the best known, and are sufficiently broad in some places to permit ox ploughing. Unlike Konso, the terraced area in Harar has not only survived the transition to a cash economy but has actually expanded, chiefly by concentrating on the production of coffee (*coffea arabica*) and chat (*catha edulis*) as export crops (Grove and Sutton 1989). As noted above where the subsistence economy of Aksum was briefly discussed, ox-ploughing in Ethiopia is potentiallly an extremely old practice (for example Ehret 2002), however, the dates of its adoption at Harar, and the age of the earliest terraces, are presently unknown.

Unfortunately, the same must also be said in reference to the flood recession farming techniques employed by the Mursi in the Omo Valley (Adams 1989 and Turton 1987).

Indeed, it is significant from the perspective of the current study that Turton's (1987) discussion of agriculture in this area criticises conservationist rhetoric for presenting the environment of the Omo and Mago National Parks as a timeless wilderness, yet makes no mention of the age of Mursi agriculture despite arguing that local resource use strategies have played a substantial role in managing this environment. However, given the problems of dating more extensive and better studied flood recession farming elsewhere, this omission is perhaps understandable. This last point notwithstanding, Mursi agriculture supports a relatively small population (approximately 5000 in the late 1970s – Turton 1987), and might be best classified as generalised owing to the wide range of activities undertaken. These include, in addition to the *décrue* cultivation of sorghum, maize, beans and cowpeas, the rain-fed cultivation of sorghum and the keeping of cattle, all of which are supplemented by hunting when necessary.

In addition to these areas, Lewis (1960: 214) mentions evidence of agricultural terracing in northern Somalia, and notes that these field areas appear to be associated with abandoned settlements. It would seem, however, that these have not received further historical or archaeological attention.

Eastern Africa

Floodwater cultivation systems similar to the Mursi practices in the Omo Valley, Ethiopia, are also operated in eastern Africa, notably by the Pokomo in the delta and floodplains of the Tana River, Kenya (Adams 1989: 25; Adams and Anderson 1988: 523), and in areas along the final, broadly west to east running stretch of the Rufiji river in Tanzania (ibid.; Koponen 1988: 225; Marsland 1938). This latter technique is termed 'mlau' by Marsland (1938), who notes that it relies on the deposition of a fertile layer of alluvium up to 6 inches thick which retained sufficient moisture to support a crop of maize, Asian rice and cotton, though Koponen (1988: 225) cites several late nineteenth-century sources which report that rice was the principal crop at this time.

Floodwater also formed the basis for sorghum cultivation among the Turkana along stretches of the Turkwel and Kerio rivers, as well as by the lake shore north of the Turkwel delta and beside those tributaries to the Sugata that are not derived from alkaline hot springs (Morgan 1974). The technique employed along the rivers is considered by Adams (1989:25) to be best classified as a form of run-off farming, but falling-flood cultivation was also observed by Morgan in the Turkwel delta, whilst Austin (1903: 204 cited by Morgan 1974: 87) recorded the presence of "some old fields intersected by tiny irrigation channels" on the lake shore north of the Turkwel mouth. For the main part, this arable production forms a supplementary role in what is often seen as a predominantly pastoral economy, but which should probably be regarded as a very generalised resource-use strategy (Morgan 1974) employed by a society that developed a pastoralist ethos in the eighteenth century (Spear 1993a and Sutton 1993). Indeed, with the possible exception of the area around Kaputir on the upper reaches of the Turkwel river (Morgan 1974), the cultivation techniques in the Turkana area would not qualify as intensive under any of the definitions outlined above. Nevertheless, the technique deserves mention here to illustrate the existence of non-intensive precolonial irrigation and serves as an example of problems associated with the introduction of externally imposed irrigation schemes; the use of indigenous irrigation having apparently declined during the twentieth century, at least partially as a result of attempts to introduce more formal water-harvesting and irrigation schemes from the 1950s onwards (Adams and Anderson 1988: 523; Hogg 1988; for environmental consequences of such schemes see Adams 1990).

On the southwestern side of Lake Tanganyika there is a further example of locally developed irrigated agriculture where rice is planted on flooded land adjacent to the lake and some streams (Adams and Anderson 1988: 524; Popplewell 1937). This, however, forms merely part of a suite of agricultural techniques employed by Fipa communities that included the planting of millet, maize, groundnuts and legumes into ridges and mounds of compost and earth (Popplewell 1937: 101; Kjekshus 1977: 41; Mbegu 1996), as well as grain cultivation via a more expansive slash-and-burn approach (Koponen 1988: 228). Under the very broad definition offered by Adams and Anderson (1988: 522) even mounding and ridging could be viewed as a form of simple irrigation if this is intended to improve soil moisture retention or drainage. Fipa mounding might not fall within this category, but it is suggested that the cultivation ridges employed in and around the Southern Highlands of Tanzania would (ibid.: 522-3). These include the broad *fyungu* ridges constructed in the Lyandembela (Ndembera) valley to the south-west of the modern town of Iringa, and further west in the Kiponzelo valley (Sutton 1969:7). This practice was observed by Sutton in the late 1960s and is described as comprising ridges of up to 12m wide separated by 2m wide ditches, with smaller ditches – some of which act as irrigation furrows – dissecting the ridges. *Fyungu* are, however, fairly widespread in the Southern Highlands where they may be used in conjunction with *matuta* contour ridges on steeper terrain. Possibly the most elaborate example of *matuta* is that practiced at Matengo to the east of Lake Nyasa near the modern town of Songea, where cross-slope ridges are combined with down-slope banks and has led to the misnomer of 'pit-cultivation' (Sutton 1969: 6 citing Pike 1938, 1939 and Stenhouse 1944; see also Adams and Anderson 1988: 523; Håkansson 1989:13 and Koponen 1988: 230).

Elsewhere in the Southern Highlands examples of more obvious forms of irrigation are also recorded and include simple furrows in the Ubena and Upangwa hills, the latter of which were described on the basis of abandoned remains as comprising carefully built "terraces" and "old irrigation channels along the slopes" (Gillman, ms dated 1925, cited by Sutton 1969:5). Similarly, to the north of the Great Ruaha River at Usagara (Ukaguru), Last reports the existence of what he describes as "the best piece of irrigation I have seen in Africa" (1883: 591 cited by Sutton 1969:8; see also Kjekshus 1977: 36) feeding fields of maize. As Sutton's observation illustrates, many of these practices in the Southern Highlands continued into the twentieth century but can probably all be regarded as precolonial in origin.

Dates for the inception of intensive agricultural practices are also problematic for the majority of instances of hill furrow irrigation in east Africa, despite these being the best studied and technically most impressive of the precolonial irrigation systems in this region. With the exception of Konso in Ethiopia discussed above, most examples of furrow irrigation in east Africa are located in western Kenya, and on either side of the Kenyan-Tanzanian border (see figure 3.2). In summarising these agronomies, Adams and Anderson (1988: 524) suggest that they can be grouped into three clusters centred around the Kerio valley, Kenya; Kilimanjaro, Tanzania, and Engaruka/Sonjo Tanzania, but it is stressed that this grouping should not be taken as an indication of cultural, historical or technological links between these systems. Nevertheless, for the later period of these systems existence at least, it is possible in many cases to discuss relationships between the communities that operated these agronomies. The history of these systems, however, remains obscure, with good dates only available for the extreme ends of the historical evidential spectrum comprising, at one end, the nineteenth-century irrigation at Arusha and Lake Baringo and, at the other, archaeological evidence for the fifteenth- to eighteenth-century occupation of Engaruka.

Sonjo, Iraqw and the Engaruka Complex

The abandoned site of Engaruka forms the primary case study here and, as such, will be discussed in considerably more detail in Chapter 5. This discussion notwithstanding, for the purposes of the current summary it should be mentioned that Engaruka is the largest of a series of sites identified on the basis of stone-lined furrows and fields, that together form what Sutton (for example 1978 and 1986) has termed the Engaruka Complex. The type site, if it can be considered as such, comprises approximately 1800ha of stone-bounded fields and dry-stone terraces, the vast majority of which were irrigated through an intricate system of channels and furrows. The fields are overlooked by terraced settlement sites located on the slopes of the Rift foothills to the immediate west. Similar habitation areas have yet to be identified at the other Engaruka Complex sites of Oldogom, Olpiro and Endamaga to the immediate north of

Lake Eyasi; at Mto wa Mbu to the north of Lake Manyara, or at Enguroto located to the south-east of Lake Natron, but the existence of field and furrow features strongly suggests these sites are related and may represent satellite communities that migrated from, or were otherwise influenced by, the society at Engaruka. The most northerly of these sites – Enguroto – was noted by Chittick in 1974 (cited by Sutton 1990b: 92) who also observed old irrigation features at Peniñ (Peninyi) to the west of Lake Natron, in an area that has occasionally been cultivated by the local Sonjo (Batemi) community throughout the last century. Although subsequent cultivation has made it difficult to confirm this observation, similar evidence from the Sonjo villages of Sale and Oldonyo Sambu add some support to the view that the irrigation-using community of Sonjo may itself be a northerly outpost of the Engaruka Complex (Adams, Potkanski and Sutton 1994: 23; Sutton 1990b: 92; see also Sutton 1986 and 1993: 53).

The case for a possible relationship between Engaruka and Sonjo had been made much earlier by Fosbrooke (1938) on the basis of the use of irrigation and the similarity of settlement design, since both communities construct(ed) nucleated villages on dry-stone terraced platforms (see below and Sutton 1978, 1986, 1990b and 2000: 218 figure 11.9). The suggestion that Sonjo irrigation may date to the earlier period of Engaruka's occupation has, however, generally been avoided. Sutton (for example 1993: 52-3 or 2000 [1998]: 33) has argued that the two communities were probably only co-existent for a century or two; a position that arises from a now well rehearsed linguistic argument (Sutton 1986; 1990a: 54; 1993: 52-3) that sees the Engarukan community as Southern Cushitic speakers who were already resident in the area when the Bantu speaking 'Sonjo' community arrived at sometime prior to the Maasai expansion into this region during the eighteenth century (though see also Lamprey and Waller 1990 and Galaty 1993 for a discussion of the dating of Maasai occupation(s) in northern Tanzania). This case is at best vague, dated is it is by a series of already imprecisely dated cultural developments or population movements, and is perhaps overly blessed with caveats, especially as regards the Engarukan origin of the hypothesised Southern Cushitic group (see, for example, Sutton 1978: 67-8; 2000 [1998]: 33) for which their appears to be no surviving linguistic evidence in modern Sonjo communities (Nurse and Rottland 1993: 4). Indeed the vocabulary for irrigation employed by the Sonjo is largely derived from non-agriculturally specific Bantu words, albeit with some terms for agricultural features that are of unknown origin (ibid.: 3). On the other hand, Nurse and Rottland did record Sonjo songs which they interpret as referring to Engaruka and were told that some clans claim ancestry from the site, though Gray's failure to record similar traditions during 1955 might suggest that references to Engaruka are a recent development or are a re-interpretation of the *Belwa* origin story (Gray 1963: 11-20).

Although linguistically Southern Cushitic and supported by an economy that includes intensive techniques, the history of the Iraqw of the Mbulu Plateau, Tanzania, would suggest that there is no connection between this community and those in the Engaruka Complex (Börjeson 2004: 80; Sutton 1993: 51-2). Genealogies suggest that Iraqw settlement dates to at least the late eighteenth century (Börjeson 2004: 80 citing Fosbrooke 1955: 17; Thornton 1980: 193-4 and Lawi 1999: 19), but the community comprises families that trace their origins to a number of 'ethnic' groups (Börjeson 2004: 79 citing Thornton 1980 chapter 8), and indeed only three clans claim decent from individuals who took part in the migration that is said to have led to the founding of settlements in Iraqw'ar Da'aw (Thornton 1980: 196). The Iraqw should not, therefore, be seen as descendents of the hypothesised Southern Cushitic group that may have influenced early Sonjo, and neither is there anything in recorded Iraqw traditions to indicate a relationship with, or even the existence of, such a community. Moreover, the physical modifications of the landscape in Iraqw'ar Da'wa are quite distinct from those at either Engaruka or Sonjo, even given differences in topography and geology. Thus, although terraces of up to a metre in height are found in upland parts of Iraqw'ar Da'wa, these are formed gradually over a period of years, and the resultant cut edges are not reveted, though they may be consolidated by planting, and protected from water erosion by the excavation of gullies as storm drains (Börjeson 2004: 78). Similarly, Iraqw furrows are restricted to valley bottoms, where they act to facilitate drainage rather than as water application features (ibid.). Soil fertility is maintained by collecting manure which is initially dried and used as stock bedding, before being piled outside and later applied to the fields; a practice that seems unique to Iraqw farming (Börjeson 2004: 77 citing Tengö 1999).

Farmers in both Iraqw'ar Da'wa and Sonjo draw a distinction between fields in different topographical positions (the Iraqw, for example, distinguish valley, hillcrest and east and west facing slopes – Börjeson 2004: 77) and plant a different suite of crops accordingly. Intercropped maize and beans are the principal valley crops among the Iraqw, who plant a broader repertoire including sorghum, eleusine (finger millet) and pennisetum (bulrush or pearl millet), wheat, cassava, numerous vegetables, and cash crops of tobacco and coffee in hillside fields (ibid.). Gray (1963: 37) reports that sweet potatoes were the main crop in irrigated lowland fields (*hura*) in Sonjo, though he may have slightly downplayed the significance of the grains with which this crop is interplanted: finger millet and sorghum (Adams, Potkanski and Sutton 1994: 30 – who consider that Gray may have misidentified the millet as pennisetum, and note the recent introduction of other sorghum varieties since Gray's fieldwork). Sorghum appears to have also been the most important 'traditional' crop in the Sonjo irrigated fields referred to as *magare*, as well as in rain-fed plots, though maize has become increasingly popular since the time of Gray's study (Gray 1963: 38; Adams, Potkanski and Sutton 1994: 29-30). Similarly, Gray (1963: 127) notes that the Sonjo kept goats but few or no cattle, apparently on the grounds that this avoided the threat of Maasai raids. Cattle are now kept, however, and it is possible that the situation reported by Gray was in itself a fairly recent development and perhaps an artefact of the great rinderpest epidemic of the 1890s, or of Maasai attempts to re-stock their own herds in the wake of this crisis. Such an explanation would account for reports of Sonjo cattle-keeping prior to this date (Adams, Potkanski and Sutton 1994: 23 citing Wakefield 1870: 312). Despite this history of combined intensive agriculture and stock-keeping, the manual application of manure to fields is not carried out, though livestock may be grazed in *magare* areas (Adams, Potkanski and Sutton 1994: 30).

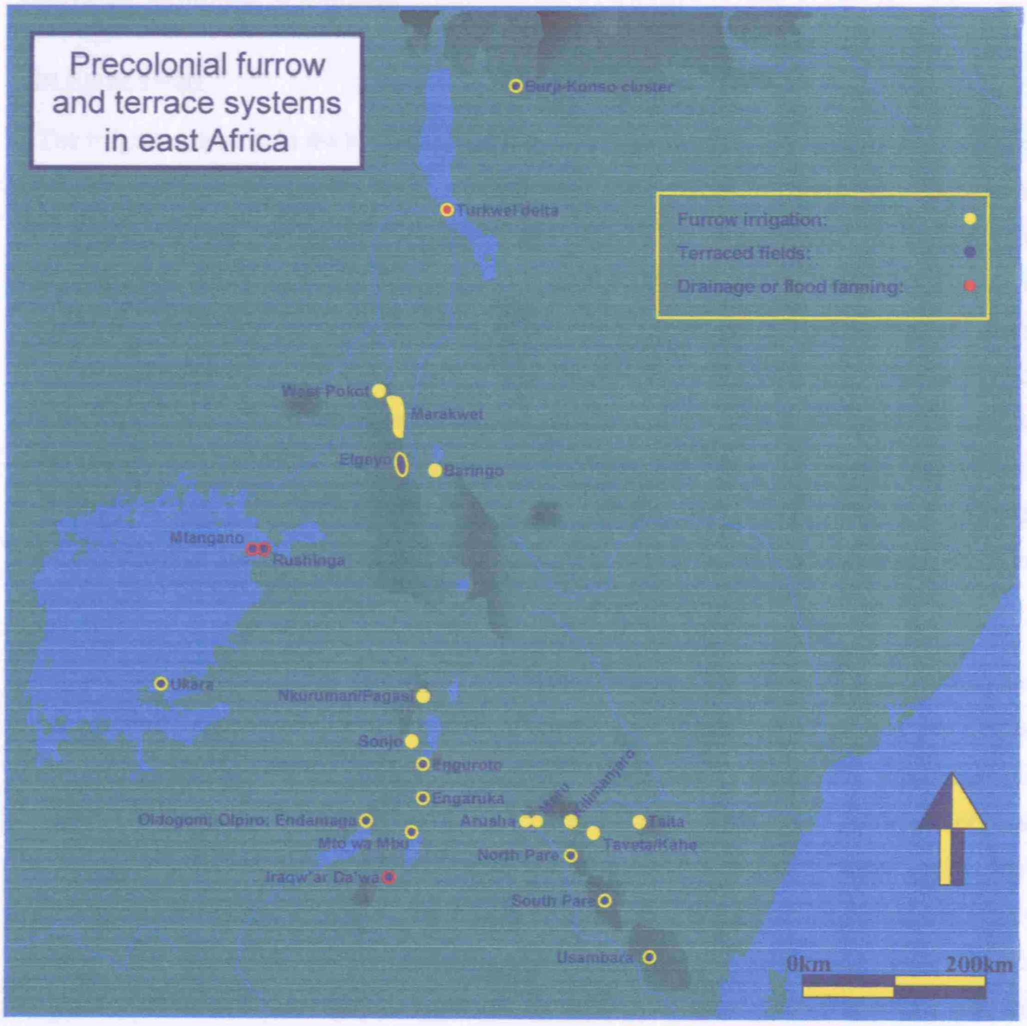

Figure 3.2: Precolonial furrow and terrace systems in east Africa

Abandoned Sonjo villages remain visible in the landscape and some are apparently well known to the Sonjo community (Gray 1963: 11; Adams, Potkanski and Sutton 1994: 22-3), not least because these are sited by water sources that seem to have been successively exploited and abandoned by the Sonjo over an unknown period. Some of these areas are now occupied by Maasai irrigation-using agriculturalists, for example at Peniñ mentioned above. The same would also appear to be true across the Kenyan border below the Nguruman escarpment to the south-west of Lake Magadi, where the Pagasi river has been used as a source of irrigation water by Maasai communities since at least the nineteenth century (Adams, Potkanski and Sutton 1994: 21 and 22; Spear 1993b: 131 citing Thomson 1885; Sutton 1993: 48; Little 1992: 30). These communities, some of which now include Sonjo families (Potkanski 1987; Adams, Potkanski and Sutton 1994), are referred to variously as Nguruman, Nkuruman or Ngruman.

The Kerio Valley

The irrigation system in the Kerio Valley, Kenya, is estimated to include forty main furrows totally 250km in length (Soper 1983), which together are capable of irrigating some 4000ha (Watson, Adams and Mutiso 1998: 41; Östberg 2004), and has been described as "possibly the most extensive and complex indigenous water management in Africa south of the Sahara" (Adams and Anderson 1988: 526). Furrows are normally simple ditches, though in places these are stoned-lined, particularly in erosion prone areas around bends, sluices, diversions or dams (Soper 1983: 81). Terraces are employed within the densest area of furrows in order to revet water channels or to form house platforms. Agricultural terraces are also constructed, particularly towards the southern end of the irrigated area around Tambach (Sutton 1985: 745; Grove and Sutton 1989: 113) where limited excavations in 1963 revealed an earlier series of terraces below the recently employed examples (Grove and Sutton 1989: 113, footnote).

Although three communities in the Kerio Valley – the Marakwet, (West) Pokot (or Suk) and Keyo (sometimes rendered Keyu) – employ furrow irrigation, the network of channels crosses these community 'boundaries', with Pokot agriculture in particular essentially an extension of the Marakwet system (Soper 1983; Adams, Potkanski and Sutton 1994; Östberg 1999 and 2004). Indeed, Östberg (2004: 31) notes several instances from the late 1950s onwards where Marakwet communities responded to conflicts with neighbouring Pokot by cutting the supply of water before it crossed into the Pokot side of the irrigation system, thus illustrating a degree of water control that is echoed in Thomson's (1887: 310) often quoted anecdote that the furrow that passed his camp was shut pending the payment of a fee. Thomson's account also demonstrates that the irrigation system was in place prior to European contact, whilst similar accounts (von Höhnel 1892; Austin 1903 – both cited by Koponen 1988 and Östberg 2004) show that this was also the case in Pokot. In terms of inception, however, the dating remains uncertain. Ehret (2002: 394) states, somewhat bluntly, that Marakwet irrigation is over 500 years old, whilst Kodalo (2000) employed oral traditions and estimations of the duration of age-set cycles to date the settlements associated with particular furrows, concluding that the Endo sub-group who occupy the most complex area of irrigation around Tot, may have built furrows more than 400 years ago. On the same basis, the furrows built by the Almo sub-group that lead from the Arror river are considered to be over 200 years old. Although such a conclusion does not entirely contradict earlier oral-historical studies, Hennings (1951), Soper (1983) and H. Moore (1983 and 1986) all note that informants stated that the earliest furrows were in place by the time the Marakwet arrived in the area.

A speculative explanation for the lack of a local tradition regarding the founding of irrigation in the Kerio Valley is offered by Sutton's suggestion that although the Marakwet, Pokot and Keyo speak Kalenjin, this language may have been introduced between two and three centuries ago by immigrants from the now 'extinct' agro-pastoralist group referred to as the Sirikwa (for example Sutton 1993: 57). Given the obvious difficulties of discerning the language of a no-longer extant community, this hypothesis must remain conjectural. The theory nevertheless accounts for the close linguistic affiliation between the existing communities in the valley (including the Tugen to the east), which in itself means that it is not possible to discern linguistically if one of these societies developed intensive agriculture before its neighbours (Rottland 1983). The theory would suggest, however, that the irrigation system predates the cessation of Sirikwa pastoralism in the seventeenth or eighteenth centuries (for a summary of this case see Sutton 1990b: 41-9 and 1993: 42-8 and 57-8).

The crop repertoire cultivated in the valley has expanded considerably in the twentieth century at least partially through external intervention (Adams 1996; Kipkorir 1983; Östberg 2004; Watson, Adams and Mutiso 1998). The 'traditional' staples, however, were sorghum and millet, albeit supplemented by a range of cultivated and gathered resources (Kipkorir 1983: 4). Trade with neighbouring pastoralists is also common, and would appear to have been more so prior to the artificial drawing of 'ethnic' boundaries in the colonial period (Adams, Potkanski and Sutton 1994: 31; Östberg 2004: 28; Bollig 1990: 75). Cattle and small stock are also kept, particularly among the Pokot, though in lesser numbers in the area to the immediate north of Marakwet where irrigation furrows are most common. Various sources and commentators mention the use of manure to aid soil fertility but only Watson, Adams and Mutiso (1998: 80) qualify this observation by noting that just 11% of those interviewed in the Marakwet area in early 1990s stated that they applied fertiliser.

In terms of relative chronology it is very tempting, on the basis of the geographical distribution of intensive agricultural techniques and oral historical information, to see the Endo area of Marakwet as the nucleus of irrigation-based agriculture in the valley, with these techniques subsequently being extended into the Keyo and Pokot areas. Indeed, Morgan (1974: 88) has suggested that the irrigated agriculture around Kaputir on the Turkwel river may have been influenced by the neighbouring Pokot, thus positing a further extension of this process. Moreover, Sutton's speculative contention that the area around Lake Baringo may have originally been a Pokot settlement (see, for example, Sutton 1990b: 28, figure; 1993: 58) might, if confirmed, substantially extend this area of influence or, alternatively, may suggest some other sequence of technological dispersal in the region. Further archaeological fieldwork may be able to shed some light on these issues of dating and cultural connections, particularly since there are differences in the level and type of landscape modification in these various locations.

Kilimanjaro and the surrounding highlands

Basing their analysis on the number of species variants, De Langhe, Swennen and Vuylsteke (1995) estimate that banana cultivation on Kilimanjaro and the North Pare mountains in northern Tanzania is at least 1000 years old. This, of course, does not mean that the furrow irrigation systems on these and the nearby South Pare and Usambara mountains are equally old, since rainfall in these highland areas is generally sufficient to support banana-based agriculture without supplementary irrigation. In an attempt to produce more precise dates for the adoption of irrigation on Kilimanjaro, Masao (1974) employed the oral historical information collated by Stahl (1964) and compared this with the names given to particular furrows, concluding that many of the channels were early nineteenth century in origin, but that the practice of irrigation was probably instigated at an early stage following the establishment of settlement sites which, he estimates, may be 300-400 years old. Tagseth (2002, 2003 and 2004), however, notes that Masao's methodology did not permit historical penetration beyond the period of political centralisation among the Chagga (sometimes rendered Chaga) in the early nineteenth century, and that Masao's estimates of settlement dates were based on the accounts of one chiefly clan, despite Stahl's statement that there were 'not less than 100' such clans prior to 1800 (Stahl 1965: 38), many of whom were sufficiently distinct to be unable to understand each others dialects (Koponen 88: 182). The implication, therefore, is that Chagga settlement on Kilimanjaro is considerably earlier, and indeed this conclusion would appear to receive qualified support from information regarding the founding of settlements and associated irrigation furrows on Mount Meru to the south-west (see below). Reports of abandoned settlements of probable Chagga origin (for example Stahl 1965: 37; Sutton 1991:

27; Fosbrooke and Sassoon 1965) may offer opportunities to attempt to date occupation archaeologically.

The dating of the irrigation system, on the other hand, is likely to be a more complicated process, since the topography and the social control of furrows by lineages led to the construction of a complex series of interconnected furrows on individual ridges (Pike 1965 citing Johnston 1886; Tagseth 2002, 2003 and 2004), with later furrows often constructed from off-takes located further upstream from those employed by existing channels. Many furrows, including the long inter-valley channels (some of which are several kilometres long and cross intervening rivers) are thus innovations that post-date the easing of hostilities between chiefdoms in the early colonial period (Pike 1965); an observation that would also account for the early nineteenth century dates for the furrows studied by Masao (1974) and Tagseth (2000, 2001 and 2004) since this would appear to be a period of systemic expansion. Nevertheless, oral traditions mention furrows in connection with seventeenth-century events (ibid.), indicating a history of local irrigation stretching back at least 300-400 years.

The possibility that irrigation on Kilimanjaro may pre-date the seventeenth century is suggested by genealogical and linguistic evidence that the Meru migrated from the Machame area on the western slopes of the mountain, settling on the lower south-eastern slopes of Mount Meru at about this time (Spear 1997 citing Dundas 1924, Puritt 1970 and Nurse 1979). If the local explanation that the first settlers brought irrigation with them is accepted, therefore, then this technology must have already been established on Kilimanjaro. There are, however, considerable problems inherent in employing these oral traditions uncritically, not least of which is that local Meru histories credit the introduction of such innovations as bananas, cereals, pottery and ironworking to a late nineteenth-century *mangi* (sometimes translated as chief but described by Spear 1997 as having limited political power) despite recalling six or seven earlier such leaders. Similarly, in contradiction to the linguistic and genealogical evidence mentioned above, the four earliest Meru clans trace their ancestry to the Shambaa kingdom of the Usambara mountains; accounts that Spear (1997: 21) rejects on the grounds that the names and institutions of these clans also appear to be Chagga in origin. Nevertheless, even though the majority of subsequent clans trace their origins to Kilimanjaro, this in itself opens up the possibility that furrows were introduced at some point after the initial occupation of Mount Meru. The question remains unsettled, but it is clear that supplementary irrigation of both bananas and annual crops was in use prior to the arrival of the first Europeans (Spear 1997 citing Rebmann 1849-50 and von Höhnel 1894), and that there was interaction between the irrigation-using highland communities in what is now northern Tanzania by at least the late eighteenth century.

Evidence for this contact comes in the form of archaeological, oral and nineteenth-century written sources. Rebmann (1848, cited by Stahl 1964 and 1965; see also Grove 1993: 445-6), for example, notes well-established markets in the Chagga chiefdoms of Kilema and Machame in 1848, whilst von der Decken records similar economic enterprises in South Pare (Håkansson 1995: 305 citing Kirsten 1869-71: 25) and North Pare; the later of which was visited specifically because the iron produced there was "as good as Swedish steel" (von der Decken 1978 [1871]: 17 cited in Sheridan 2002: 83), and had been long-traded with the Chagga where chiefly power was associated with ironworking (Spear 1997: 27; Moore and Puritt 1977: 7). Although some of these markets and their associated settlements – such as those on the western slopes of South Pare – developed as a response to the nineteenth-century caravan trade (Håkansson 1995; Kimambo 1969 and 1996a; Sutton 1991), it is clear that commercial exchanges of manufactured objects and foodstuffs pre-date these developments (Kimambo 1996a: 74; Spear 1997: 27), and were founded on a base provided by intensive irrigated agriculture, itself supplemented by rain-fed cultivation and cattle keeping.

Terraces and irrigation furrows were also employed at both North and South Pare, and both agronomies maintained soil fertility by the application of organic material to intensively cultivated areas (though see Håkansson 1995: 305 for a discussion of the contradictory accounts of the extent of manuring in South Pare). In 1985 Sutton noted the continued use of terraces at Vudee on the western slopes of the South Pare hills, though by 1989 this practice was largely falling into disuse (Sutton 1985; Grove and Sutton 1989). Håkansson (1995), however, also observed terraces on the eastern and southern slopes of South Pare, with the features here acting primarily as a means to limit erosion caused by irrigation, though the practice was also used to increase the cultivatable area on steep slopes. However, even where terraces remain in use construction seems not to have been undertaken since the late nineteenth century (Håkansson 1995: 305). Indeed, this lack of maintenance of terraces and other soil conservation techniques has been cited as a possible cause of declining productivity (Kimambo 1991: 141). The channel and furrow irrigation system, in contrast, is still actively maintained, rebuilt and extended (Yoshida 1985; Tagseth pers. comm.); a process that seems to have obscured or re-used the areas of abandoned fields and furrows reported by Bauman (1891 – cited by Håkansson 1995). As in the other communities employing furrow irrigation discussed thus far, the date of the inception of the system on Pare remains uncertain, though oral traditions record the practice in South Pare in the eighteenth century (Kimambo 1969: 80). Other traditions appear to date the arrival of chiefly clans from the Taita Hills to the seventeenth century (Kimambo 1969: 87). Since irrigation is also practiced at Taita (Fleuret 1985), the possibility of some form of technology transfer cannot be discounted, but this must remain speculative pending better dating of the Pare and Taita systems.

What is certain, however, is that in the eighteenth and nineteenth centuries the communities in North and South Pare developed very different political structures, with the latter undergoing a period of fragmentation (Kimambo 1969 and 1996a; Håkansson 1998) whilst the former became increasingly centralised under the Ugweno Kingdom (Kimambo 1969 and 1996), albeit with a small independent community developing around Usangi towards the end of the eighteenth century. This centralisation may account for the development of the *marombo* (singular *irombo*) irrigation system at North Pare: annually re-built river dams that produced a reservoir to feed irrigation furrows. Generally situated in the lowlands, these features were centrally controlled (Kimambo 1991: 20; 1996: 80; Sheridan 2002: 86), and were thus managed very differently from the *ndiva* furrow reservoirs and intakes in North and South Pare which were (and are) managed by patrilineages descended from the structures' founders (for South Pare see Håkansson 1995: 305; for North Pare see Sheridan 2002: 86-88). Oral evidence suggests that most *ndiva* date to the eighteenth and nineteenth centuries (Kimambo 1969: 80; Håkansson 1995: 303-4; Sheridan 2002: 88), but the practice itself predates the *marombo* and may be as old as the patriclans themselves, some of which trace their ancestry for up to twenty generations (Sheridan 2002: 82). Technical and dating similarities between the two systems in Pare are not reflected in terms of the management and local perception of irrigation, however, particularly as regards the sexual division of labour.

Like Ugweno and parts of Kilimanjaro, the irrigation-using communities on the Usambara mountains had fallen under the control of a single chiefly dynasty, in this case, some time in the eighteenth century (Feierman 1974 and 1990). This lineage – the Kalindi – not only supplied the king at the capital at Vugha in west Usambara, but also extended its influence by supplying chiefs to other communities in the mountains and surrounding foothills. Despite an apparent conceptual link between the rain making powers of the king and the irrigating properties of furrows, Kalindi rulers of the Shambaa Kingdom did not exert direct control over furrows or dictate water management. Instead, the major furrows were controlled by an elder of the lineage associated with that furrow, and whose responsibilities included carrying out sacrifices to bless the structure. Smaller furrows were managed and maintained by the farmers whose fields they served. On this basis it seems certain that the practice pre-dates political centralisation (Feierman 1990: 65; Kimambo 1996a: 73 citing Fleuret 1978) and thus may be assumed to be at least early eighteenth century in date. If this is the case, in less than two centuries the network of furrows had expanded to the point where it was described as irrigating "several thousand hectares" (Holst 1893 cited by Koponen 1988: 232-3). For the main part, irrigation fed banana groves, though in the nineteenth century lowland (*nyika*) areas were planted with introduced crops such as maize and cassava.

Trade-oriented 'oasis communities' of the nineteenth century

In addition to the areas discussed above that might be best described as late Iron Age in date, there are also a group of irrigation-using communities that developed (or at least flourished) as a direct result of the caravan trade from the Swahili coast in the nineteenth century. Spear (1993a, 1993b and 1997) refers to these societies as 'oasis communities'; a reflection both of their ecological setting as pockets of irrigation on the fringes of semi-arid plains, and of their role as refuges for dispossessed members of neighbouring populations. Of these, the most famous during the nineteenth century was probably Taveta, located to the immediate south-east of Kilimanjaro on what is now the Kenyan side of the border. By the late nineteenth century Taveta had developed into a fortified settlement that produced bananas, maize, sweet potatoes, yams and beans; traded salt and honey, and also kept stock and trapped animals (Frontera 1978; Spear 1993b: 131-2). The first major caravan stop on the Mombasa trade-route, the town was also well placed to benefit from trade along the Pangani river to Kilimanjaro and, indeed, on the basis of the recovery of the same pottery types from Taveta, Taita, Pare, Usambara and coastal sites such as Lakwa on Manda island, it is clear that the area had been involved in some form of trade (whether direct or indirect) from at least the ninth century (Abungu and Mutura 1993: 695). The town itself, however, probably dates to around the end of the seventeenth century (Frontera 1978: 49), with the origins of the irrigation system likely to be of comparable age (ibid.: 9). Although sometimes regarded as a predominantly Maasai settlement due to the adoption of Maasai age-sets, the community appears to have been linguistically and culturally most closely associated with Pare, and to have also included individuals who could be described as Chagga and Shambaa (Frontera 1978; Spear 1993b and 1997; Sutton 1993: 58). With the exception of the Chagga speaking settlement of Kahe to the south-west of Taveta, the other irrigation-using 'oasis communities' of Nkuruman, Chamus and Arusha were all culturally Maasai.

Two of these Maasai communities have been mentioned already: Nkuruman, where agricultural Maasai farm an area that may have previously been exploited by Sonjo, and Chamus of the Lake Baringo area in Kenya, whose use of irrigation in the late nineteenth and early twentieth centuries was summarised in the introduction (pp. 17-18) as an example of a relatively rapid change in subsistence strategy. Whilst the Chamus now practise irrigation only sporadically (Little 1985), the Arusha still employ irrigated agriculture and must have adopted the practice either immediately upon, or very shortly after, establishing the two settlements of Arusha Chini and Arusha Juu, since oral evidence dates the founding of Chini to the early nineteenth century and the establishment of Juu at sometime during the Kidotu age-set of c.1821-41, yet both communities are recorded as operating well-established irrigation systems by the late 1840s (Spear 1993b: 122; Spear 1997: 38 and 41, in both cases citing Rebmann 1849-50. For a reconstruction of the dates of late eighteenth- and early nineteenth-century Massai age-sets see Galaty 1993: 74 or Spear 1997: 42). Indeed some traditions state Supreet, a prophet (*loibon*) of the Enkidongi Maasai, had instructed the Arusha to dig furrows to produce tobacco and food crops for the pastoral Maasai (Spear 1997: 41; for a discussion of the problems of dating events in relation to *loibon* genealogies see Waller 1995). The balance of oral traditions, however, would indicate that the alliance between the Arusha and the Enkidongi prophetic leaders post-dates the founding of Arusha Chini, the initial settlers of which were probably Parakuyo Maasai who, although resident in the area from the seventeenth or eighteenth centuries, had fared badly in confrontations with advancing Kisongo Maasai in the early nineteenth century (Galaty 1993; Spear 1993a, 1993b and 1997; Sutton 1990 and 1993).

Regardless of which interpretation is accepted, the establishment of a market for livestock, arable crops and gathered resources at Sanguwezi (approximately 3 km to the west of Arusha Juu) demonstrates that the Arusha were actively maintaining contact with their pastoral neighbours, and were apparently cementing these through stock partnerships and intermarriage. At the same time, relationships were built with nearby agriculturalists, albeit sometimes aggressively as with raids on Meru for women and men; the former being married or effectively adopted in order to permit the receipt of bride-wealth payments, whilst the latter were assimilated into Maasai age-sets (Spear 1993b: 125). Interactions with other agriculturalists were obviously not always so hostile, however, as is indicated by Gulliver's (1963:12) assessment that 44% of Arusha lineages traced their origins to Meru, whilst 22% were derived from Chagga. On this basis alone it seems very likely that Arusha furrow irrigation owes a debt to the expertise of their highland neighbours, and indicates that the possible "cultural, technological or historical linkages" that Adams and Anderson (1988: 524) suggested might exist between neighbouring irrigation-using communities are probably traceable, at least for the more recent past.

The islands and hinterland of Victoria Nyanza

Having commented on the level of interaction between intensive agronomies within the three broad geographical clusters identified by Adams and Anderson (1988), it is necessary to restate their caveat when discussing the use of intensive agriculture on the islands of Victoria Nyanza. Indeed, in the absence of information suggesting links between other islands or the mainland, these agronomies appear, superficially, to be the best candidates for the generalised models outlined above, since they might reasonably be regarded as isolated and certainly have fixed limits on their ability to expand the area under cultivation. This observation is not lost on proponents of the population-push or siege hypotheses, who are apt to cite the example of

Ukara Island, Tanzania, as a clear African case study of the advantages and potential pitfalls of highly localised intensive agriculture (for example Koponen 1988: 364; Netting 1993: 52-3; Pingali, Bigot and Binswanger 1987: 43; Turner, Hanham and Portararo 1977).

Citing Ludwig's (1968) study of Wakara agriculture, Netting (1993: 52-3) notes a population of 16,000 in 1965 on an island totalling approximately 78 km²; figures that represent an approximate population density of 205 people per km², and thus well above the threshold of 60/km² that Netting (1993: 269) tentatively suggests is the point at which communities will feel pressure to intensify production. Indeed, 200/km² in a rural location is considered to be the approximate point at which continuous cropping techniques will be necessary, and thus Ukara is seen as offering support to this equation (ibid.). Considerably higher population figures have been suggested for Ukara, however. Writing in 1936, Thornton and Rounce estimate that of the total land area, only approximately two thirds were suitable for cultivation and thus with a slightly higher population figure of 17, 506 offer a population density of roughly 338/km². This compares with a late nineteenth-century population estimate of some 300/km², though this figure is coupled with an observation of the exportation of surpluses and the comment that "the whole area of the island is utilised, nowhere is fallow land to be seen" (von Schwienitz und Krain 1893: 483, cited by Koponen 1988: 235).

In order to support a population of this size a range of intensive agricultural techniques were developed, including the construction of earth and dry-stone terraces up to 2m high; furrow irrigation; contour ridging and ridged pathways for cattle; the banking of streams; the interplanting of crops; and the planting of euphorbia or other species in erosion gullies to check further soil loss (Ludwig 1968: 120; Thornton and Rounce 1936: 31). Soil fertility was maintained by green manuring and by the feeding of cattle in pit-stalls to accumulate fertiliser, whilst Ludwig reports that manure was carried back from off-farm grazing areas. Such areas were, like the arable fields, privately owned and indeed, on the basis of decreasing field size as a result of a system of inheritance by several descendants, Thornton and Rounce (1936: 31) consider individual ownership be a well established, and potentially detrimental, system of tenure. Indeed, even trees were privately owned by this time and are reported to have been occasionally sold independently of the land on which they stood (ibid.: 30). These were generally pollarded to produce building material and cattle fodder. Dwarf zebu cattle, sheep and goats were kept at a density of approximately three cattle and four small stock per adult male in 1936, and were viewed as sources for milk and fertiliser rather than as meat or stored wealth (ibid.: 27-8). In addition to the fodder sources mentioned above, cattle were grazed on crop residues; in fields of young thatching grass, and in lake shore meadows, some of which were irrigated via excavated channels.

Both Thorton and Rounce and Ludwig mention the same principal crops: Pennisetum (pearl millet) intercropped with bambarra ground nuts. Sweet potatoes were often sown as a catch-crop following the millet harvest. Relatively fertile fields in valleys and by lake shores were planted with rice and irrigated by damming streams, the rice having been raised in nursery beds and subsequently transplanted. From a comparison of the two cited accounts it would appear that the importance of rice as a cash crop had increased in the early twentieth century. As with many of the intensive agronomies in the region, the dating of the inception of the system remains unknown. On the grounds that it was not just well-established but actually covered between 50 to 80 square kilometres by the turn of the twentieth century, however, it might be assumed to be at least early nineteenth century in origin and may prove to be considerably earlier. Such an assessment is likely to require both concerted oral historical enquiries and targeted archaeological fieldwork.

Similar work would also be necessary to date the agricultural system of Mfangano and Rushinga islands, located just off the Kenyan lake shore near the mouth of the Winam Gulf. Dated by oral evidence to at least the eighteenth century (Conelly 1994: 152), the two agronomies are clearly closely related, although that at Rushinga has undergone a process of substantial disintensification during the twentieth century, apparently as a result of a combination of factors facilitated by its proximity to the mainland, to which it is now connected by a causeway. These include the availability of off-farm wage labour, and the increased profitability of commercial fishing created by better access to markets. Correspondingly, many terraces and lake shore fields on Rushinga have now been abandoned, but those on Mfangano are sufficiently similar to demonstrate how both systems operated in the early twentieth century.

The cultivation area on both islands comprises three ecological zones, with most families farming land in each. Dry-stone terraces averaging 500mm high and built between 3m and 10m apart are mainly restricted to areas above 1400m and are used for the rain-fed cultivation of maize and sorghum. Fallows of two to five years were considered by Conelly (1994: 157) to be common in this area. Scattered settlement compounds and their associated fields are located below the terraces. These fields are rarely fallowed and are planted with grains, legumes, cassava and occasional fruit trees. Cattle and small stock are kept in this area, but may also be grazed in any of the cultivated zones. The final ecological zone is bordered by the lake shore and the habitation area. This too is used for arable production and includes the widest range of interplanted crops, principally maize, sorghum, cassava, sweet potatoes, sugar cane, bananas, along with fruit trees and several vegetable varieties. The systematic application of water to these fields is not undertaken, but channels may be excavated to improve drainage and certain crops may be grown in mounds for the same reason (Conelly 1994: 157-8). However, using population densities as a measure, Conelly regards Mfangano agriculture as only semi-intensive (with an average of 104/km²) and Rushinga (with densities in the region of 230/km²) as currently disintensifying for the reasons outlined above (Conelly 1994: 153 and 159). Whether these population densities reflect those of the precolonial period, however, is unknown.

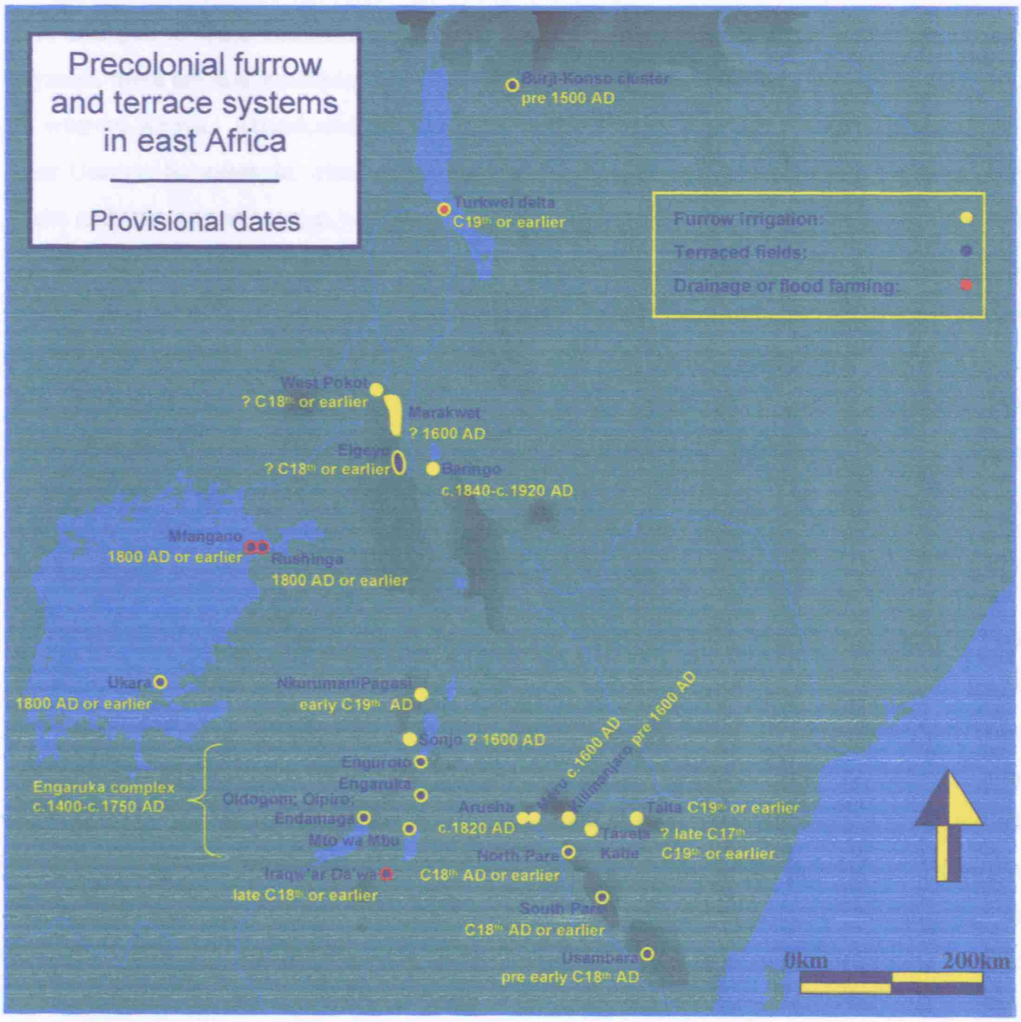

Figure 3.3: Precolonial furrow and terrace systems in east Africa: provisional dates

Further instances of field-systems, terraces and possible irrigation features are recorded in other islands in Victoria Nyanza. These, however, have generally been recorded on the basis of archaeological evidence visible on the surface and thus the stumbling block here is less the age of the system, and more the difficulty in assessing the level of intensification. Nevertheless, earth bunds up to 150m long and approximately 15m apart have been reported from Lolui island, where they appear to be associated with stone lines, possible terraces and stone cairns (Posnansky, Reid and Ashley 2005, and Reid pers. comm.). Similar remains, including cairns and stone lines that probably represent field-divisions have also been observed on the islands of Bugaia and Bugala. Artefacts associated with these structures, in particular an apparent association with Entebbe ceramics, would suggest that these features are Late Iron Age in date, and were probably in use in the early to mid- second millennium AD (ibid.).

In addition to these instances of irrigation and terrace systems on the islands of Victoria Nyanza, there are also examples of terraced and irrigated agriculture on or near the lake shore in western Kenya. Abandoned and currently cultivated stone-revetted contour terraces exist near Usenge, for example, where preliminary surveys and oral historical studies conducted by Lane and Oteyo (pers. comm.) indicate that these were constructed by Luo communities, with the structures themselves dating to at least the early nineteenth century. The terraces are most evident on low hills, the summits of which may have been employed as habitation areas and for the stallage of stock. These hillside terraces overlook areas of stone-bounded fields which would seem to be of comparable date, whilst current agricultural practices suggest that the cultivation of these terraces and fields may have been combined with the exploitation of areas of low-lying marsh.

Western Rift Highlands: Burundi, Rwanda and Uganda

Citing Gulliver (1953), Grove and Sutton (1989: 121) note the use of wood-revetted and earth terraces in the mountains of eastern Uganda in land occupied by the Tepeth and Teuso. Examples of extensive terracing employing both stone revetting and simple earth and wood-lined structures are also recorded for parts of Rwanda and Burundi (Sutton 1985: 747), but these systems appear to have received little or no attention in terms of historical research and may have been obscured or destroyed by twentieth-century agricultural schemes (Grove and Sutton 1989: 121-2). However, extensive areas of terracing continue to be employed in the Kigezi district of Uganda where the practice appears to be precolonial in origin, albeit of uncertain date (Grove and Sutton 1989: 122 citing Martin 1940; Carswell 2002: 130). Terraces in Kigezi are generally not reveted by stone, nor are they levelled (see for example Sutton 1985: 748, Plate 2), and instead appear to be constructed simply to limit soil erosion rather than as moisture retention or soil accumulation features. In contrast to many of the systems outlined thus far, Kigezi agriculture has consistently been maligned by colonial and post-independence era government reports as well as by more recent NGO assessments, the majority of which have regarded the system as facing collapse due to soil exhaustion, erosion created by population pressure and, ultimately, "poor farming practices" (Uganda Government

1994, cited by Carswell 2002: 132). This conclusion, however, is refuted by Carswell (see below).

In addition to these terrace-using communities, a system of irrigation incorporating dams and channels is recorded from Agoro in northern Uganda (Adams and Anderson 1988: 527 citing Watson 1952).

Southern Africa

With the exception of the two archaeological sites summarised below, furrow irrigation would appear to be largely absent, or at least largely unreported, in southern Africa. Indeed, indigenous irrigation of any kind seems to be quite limited in this region, with Adams' (1989: 25) brief gazetteer mentioning only the floodwater farming techniques employed in the Okavango Delta, Botswana, and in the Pongolo floodplain in South Africa, though Soper (2002: 27-8 citing Whitlow 1983) notes that seasonally flooded stream headwaters known as *vleis* may have formed an important element of local agriculture prior to their suppression by colonial authorities who saw them as limiting dry season stream flows. Similarly, the use of raised beds to farm waterlogged areas appears to have been more common in Zimbabwe in the recent past (Soper 2002: 55 citing Mukaronda 1988). Knowledge of precolonial terrace systems would seem to be equally lacking, though both Sutton (1985: 747) and Grove and Sutton (1989: 122) note the unconfirmed existence of abandoned terraces in Swaziland and the eastern Transvaal in South Africa. One of these sites, however, has since been firmly identified by Maggs (1995 cited by Wigren 1999, 2000 and 2004). The site in question is referred to as Marateng, and comprises stone-built terraces, field divisions, kraals, cattle pathways and probable irrigation furrows. Located around Lydenburg in the northern Drakensberg, the agronomy may have survived into the nineteenth century, with abandonment tentatively linked to Boer occupation of the area (Widgren 2004: 10-11 and Widgren forthcoming). However, detailed information regarding the length of occupation prior to abandonment, and the crop repertoire utilised, must await a more comprehensive investigation.

The largest and best studied precolonial intensive agricultural area in southern Africa is the abandoned site of Nyanga (rendered Inyanga in the earlier literature), located in north-eastern Zimbabwe, bordering Mozambique. The most obvious features in the landscape are large groups of stone-built terraces which, on the basis of aerial photographs, cover a minimum of 22,000ha (Soper 1996, 2000 and 2002). However, the complex also includes a series of roughly-coursed, dry-stone habitation sites, and an extensive network of cultivation ridges and associated ditches that covers an area at least equal to that of the terraced hillsides. The site has been the subject of a number of archaeological investigations, including a survey by

Randall-MacIver at the turn of the twentieth century and several excavations in the 1930s (Soper 1996: 1). Three seasons of excavation were also carried out by Summers and Robinson between 1949 and 1951 (Summers 1958) but, as at Engaruka, this early work prioritised the habitation areas rather than the agricultural system. Recent fieldwork by Soper (1996, 2000 and 2002), however, has gone a long way to rectifying this situation.

The terrace builders appear to have favoured soils derived from dolorite, though in places the terrace system extends into areas where granites form the solid geology. From the results of excavated transects across several terraces it appears these were constructed by trench-building the lower courses of the retaining wall, with subsequent courses formed from stones removed from the topsoil within the terraced field (see Soper 1996: 8-9, figures 5 and 6; Soper 2002: 45 figure 12). The end result of this process is a stone-free cultivation horizon bounded by walls that may extend up to 1m above the level of the field, these upper courses being effectively stone clearance features rather than soil conservation structures. Drains are frequently built into these walls at field level to allow surface water to pass downhill, further illustrating that the walls above the soil level are not designed to act as dams (see Soper 2002: 44 figure 11). Indeed, the terraces themselves are not strictly levelled and in some areas slope at angles of up to 40°. Since, in the excavated examples, the terrace walls were all founded on the same 'natural' deposit, it is not possible to discern stratigraphically whether the terrace system expanded up- or down-slope. Although the vast majority of these terraces are rain-fed, furrows were constructed through the terraced area to serve settlement sites, and may have also been used to irrigate some fields (Soper 2000: 204 and 207).

The design of the areas of cultivation ridges differs according to topography, and indeed variants in the arrangements of beds and ditches may occur within a single location (Soper 2002: 205-6). Soper has described these areas as generally appearing dendritic, an apt representation of a series of ditches that draw water from one or more furrows, with these furrows themselves sometimes connected to streams (see, for example Soper 1996: 12, figure 9). This arrangement makes it clear that the ridges are not always simply raised beds designed to allow the exploitation of naturally waterlogged areas, but are also capable of being irrigated, and indeed it would seem likely that they fulfilled both of these functions at different points in the cropping cycle. From the section drawings of excavated examples (Soper 1996: 13, figure 13; Soper 2002: 57 figure 20) it would appear that the ditches were periodically re-cut (Soper 1996: 11; Soper 2002: 58), and it is thus probable that humus-rich sediments from the base of these ditches were incorporated into the cultivation ridges. These same excavations were located in an area where both ridges and terraces occur in close proximity and encountered deposits of sandy clay loam that were interpreted as having been derived from the now terraced areas. Ditches cut through this deposit were thus taken as evidence that the ridged area was under cultivation both before and after the terraces were constructed (Soper 1996: 11-13; Soper 2000: 205-6).

In the absence of good dating material from the cultivation areas themselves (save a single radiocarbon date with a range of 1618-1878 calAD, recovered from a terrace cultivation horizon, rather than construction context – Soper 2000: 204), it has been necessary to date these provisionally by reference to associated habitation areas, the earliest of which are located well above the terraced zone and thus may predate the adoption of terraced agriculture. In consequence, despite a probable occupation of the highland sites in the fourteenth or fifteenth centuries AD, the terraces themselves may not have been constructed until the mid- to late seventeenth century, with the practice being abandoned at some time in the nineteenth century (Soper 2000: 210-11). The lowland cultivation ridges may have been exploited for a slightly longer period, but pending better dating evidence it appears that they are broadly contemporary with the terraces.

Similarities in design and function of the various habitation structures indicates some form of cultural connection between the communities that built both the highland structures and the terraces, however. In particular, the habitation structures built within the terraced areas not only employ congruent construction techniques to those elsewhere in Nyanga, but also incorporate sunken stock containment features that are similar to those built within highland sites (Soper 1996: 14-24; see also Summers' building typology – 1958: 14-17). These cattle pits themselves serve as evidence of intensive agriculture because their size and design indicates that stock formed an integral part of a predominantly arable economy. The most elaborately built examples have dry-stone walls and stone paved floors, and are entered via low tunnels supported by stonework. Measuring between three to 10 metres in diameter and between two and three metres in depth, the pits incorporate drainage slots which often lead to either natural or artificial hollows, the latter presumably features for accumulating slurry to act as fertiliser (Soper 1996: 15; 2000: 208-9). The size of pits generally increases with altitude, thus indicating the relative importance of stock the further one gets from the terraced area. Nevertheless, these larger pits do not seem big enough to accommodate a herd of sufficient size to support purely pastoral economy, even given that faunal evidence indicates that the cattle kept were of a dwarf variety (Plug, Soper and Chirawu 1997; Plug and Badenhorst 2002), and that the layout of the buildings that surround the central pit suggests that goats and/or sheep were stalled within the settlement houses (Soper 2000: 208). In addition, even these highland sites include rectangular raised platforms that are interpreted as granary bases (Soper 1996: 14-24), whilst the construction of wide 'pathways' through the terraced area might suggest that stock were regularly driven between the highland and lowland zones, though it is possible that some of these features were constructed to act as storm drains (Sutton 1984: 34).

Taken together, the evidence from Nyanga suggests a integrated economy based on the rain-fed and irrigated cultivation of annual crops combined with the raising of stock, the manure from which was used to fertilise 'garden' areas or fields adjacent to the settlement sites. Archaeobotanical evidence indicates that crops included sorghum, millets (eleusine and pennisetum), ground bean (Voandziea subterranae), cowpeas (Vigna unguiculata), castor oil plants and various cucurbits (Summers 1958: 175-7; Soper 1996: 29; Jonsson 2002). On the basis of the paucity of local oral tradition referring to the site and an apparent lack of contact with the neighbouring and contemporary Mutapa state or with Portuguese traders, Beach (1996: 717; 2002) has argued that the population of Nyanga was never as large as a superficial correlation with site size might suggest. Accepting Beach's conclusions requires a model whereby a small population continually built and abandoned both terraces and settlements, and indeed this is the schema preferred by Soper (1996; 2000; 2002 – see also Summers 1958: 257), who argues that only those areas adjacent to settlements would have been fertilised and continuously cropped, whilst a process of rolling expansion or a long fallow regime would have operated on the terraced and ridged fields. Limited evidence of modification of the settlement sites is cited as supporting this case, since this would indicate that the homesteads did not house a succession of generations, and thus that they were probably periodically abandoned as the cultivated area shifted (for a summary see Soper 1996: 32-33; 2000: 211-2). The question of why the complex was abandoned remains unsettled, but both Soper (1996; 2000; 2002) and Sutton (1984 and 1989b) argue for a combination of environmental, social and possible climatic factors. However, if Beach's (1996 and 2002) conclusion that the complex was built by ancestors of the Nyama is correct, internecine struggles recorded in Nyama oral tradition for the nineteenth century may indicate that, ultimately, the abandonment of the system may have had a political catalyst (Soper 1996: 34 citing Beach 1995; Soper 2002).

Summary: the historical critique of the generalised models

> The rapidity of plant growth, malnutrition from an unbalanced diet, famine, disease, and warfare have all combined to act on the mentality of the people, so, while they [Africans] are not usually slow to adopt improvements that affect the obtaining of food, such revolutionary inventions and developments as the use of the wheel, irrigation systems, or the growth of professionals or experts seem never to have been adopted.
>
> (Clark 1962: 29)

> Before colonization, and prior to the beginning of the 20th century, there was little agriculture in East and Southern Africa.
>
> (Nandwa and Bekunda 1998:5 cited in Widgren 2004: 18).

As Sutton's (1989b: 98) comment on the absence of '*ordinary* fields' or '*typical* techniques of cultivation' implies, gazetteers of the sort presented above cannot be viewed as evidence of continent-wide practices or of congruent subsistence strategies. On the contrary, despite evidence of various forms of cultural contact between neighbouring intensive agricultural communities, similarities in terms of the broad techniques employed are often superficial, and do not detract from the conclusion that these societies are culturally and economically distinct. Indeed, although it is undoubtedly true that colonial administrative boundaries and early approaches to ethnography accentuated, or even helped create, community identities (Adams, Potkanski and Sutton 1994: 31 and Östberg 1999: 33 citing Kipkorir 1973 in reference to Marakwet; Fardon 1987 more generally), it is equally true that closely related communities such as those in the Pare mountains developed quite different social mechanisms for the management of resources (Sheridan 2002; Håkansson 1995). Similarly, the geographical proximity of the irrigation-using societies of Meru and Arusha may have led to a high degree of transfer of both people and technologies, but this has not led to the predicted cessation of an apparently anachronistic age-set system or 'pastoral ideology' that the Arusha inherited from their cattle-keeping forebears (Spear 1997: 48 and 56-57, contra Gulliver 1965). The above gazetteer is included here, therefore, simply in order to introduce 'sites' of African intensive agriculture, thereby illustrating the range and diversity of local approaches to resource exploitation. Although the themes and essentialisms outlined in the preceding section have been applied to many of these cases by various writers, it is not the intention here to discuss these issues on a case by case basis. Rather, the primary aim is to highlight the importance of placing instances of intensive agriculture in their historical context. This leads to two supplementary objectives: to draw upon research of these or analogous systems to question the applicability of the general models outlined in the preceding section, and to assess the ability of archaeological enquiries to gain access to pertinent factors necessary to produce this historical contextualisation.

In attempting to outline the history of indigenous intensive agriculture in sub-Saharan Africa, it has been necessary to pre-empt the discussion in the following chapter. This is because it has not been possible to produce a simple gazetteer of clear-cut examples of intensive agriculture and tabulate pertinent factors such as age; population density; crops grown; techniques employed; fallow lengths; land tenure or trade relationships. Moreover, even if this were broadly possible in some instances, such a table would certainly lack sufficient detail to track changes in these factors through time. This in itself highlights problems with attempts to cite the 'history' of African agriculture in defence of developmental interventions in that this history is not, at present, sufficiently well understood to draw definitive conclusions, and is far too diverse both spatially and temporally to enable the formulation of simple 'lessons from the past'. On the basis of current data, for example, the history of Marakwet indicates that the techniques employed have allowed intensive agricultural production for at least four centuries and, as such, it might be tempting to conclude that aspects of the agronomy could be replicated elsewhere (see, for example, Kipkorir, Soper and Ssennyonga 1983; Ssenyonga 1983). Yet similar techniques in Arusha are less than two centuries old, and appear to be showing signs of strain insofar as the system requires increasing levels of labour-inputs to maintain soil fertility: the nineteenth-century practice of rotating fields between crop production and cattle pasture having been replaced by the stallage of cattle with its attendant needs for the transportation of fodder and manure (Spear 1993: 128 and 135; 1997: 53). In contrast, the long predicted Malthusian collapse of the agricultural system in Kigezi has yet to occur, and indeed, an historical comparison of fallow lengths – Boserup's ready-reckoner of the degree of intensification (1965: 28; 1981: 19) – shows that these have been increasing over the course of the twentieth century (Carswell 2002). Widgren's (1999: 6) initial stated aim of attempting to define a "common explanatory framework" for why some African intensive agronomies survive whilst others are abandoned, is thus extremely ambitious and is certainly complicated by lack of good historical data for many of the potential case-studies (Widgren 2004: 11).

Nevertheless, the state of historical knowledge is more that sufficient to refute the stance taken in the Clark quotation above regarding irrigation and, by extension, the existence of agricultural 'experts', whilst the quotation cited by Widgren would have looked naïve even if it had been written a hundred years earlier. Taken together, therefore, the case studies in the above gazetteer illustrate that African intensive agriculture has a long and complex history and, when examined individually, highlight problems with the blanket application of the general models in specific instances. Thus, for example, although Wittfogel (1957: 166) cites Pokot irrigation in support of his hypothesis that such systems require the central control of resources, Pokot furrows would appear to be an extension of those at Marakwet where the construction and maintenance of irrigation features are organised by co-operation within clans (H. Moore 1983, 1986; Östberg 1999, 2004; Soper 1983; Watson 2004; see also pp. 137-139 below). Equally, Börjeson (1999 and 2004) has questioned the applicability of the siege hypothesis for Iraqw, noting that there is no historical evidence for a sustained threat to the community and that the absence of such a hazard in the late twentieth century has not led to disintensification. Conversely, Conelly (1994) and Håkansson (1989: 13) note that communities from Rushinga and Usambara have disintensified their agricultural practices since the nineteenth century despite experiencing populations growth, whilst Östberg (2004) considers population rises to be a consequence rather than a cause of intensive agriculture in

Marakwet. These and other studies (for example Anderson 1988 and 1989; Håkansson 1995; Netting 1993; Spear 1997; Tiffen, Mortimore and Gichuki 1994) have also highlighted the importance of markets in terms of both the adaptation and adoption of intensive agricultural techniques (though this relationship may be the inverse of that expected – Loiske 1999), and draw attention to other factors such as out-migration and the importance of non-farm incomes among contemporary members of these communities (for example Carswell 2002: 138; Loiske 1999; Murton 1999). Similarly, Soper's interpretation of Nyanga introduces the issue of social or political factors by recognising that even if the agronomy was suffering from physical degradation, the community's response to this situation is likely to have been affected by non-economic issues, and will have been understood via local conceptions of the environment and causation.

It is these social and religious/cosmological factors that will form the focus of the next chapter, since doing so permits a more in-depth critique of the general models of agricultural development, and allows an assessment of archaeology's ability to contribute to debates that employ conceptions of agricultural history. In line with this approach the archaeological visibility of more mundane factors such as tenure systems and cropping strategies will also be explored. The discussion will thus combine the argument presented in chapter 2 with the data-set summarised above to assess whether archaeological enquiries can offer insights regarding the value of indigenous knowledge. However, as was established in the preceding chapter, there are problems with the translatability of indigenous knowledge, particularly as regards epistemology, rationality and causation. It is therefore worth examining how these factors manifest themselves in terms of local agricultural practices.

4

The social dimension to African agriculture

> Most African societies belong to an economic order very different from ours. Theirs is a mainly subsistence economy with a rudimentary division of productive labour and no machinery for the accumulation of wealth in terms of commercial or industrial capital.
>
> (Fortes and Evans-Pritchard 1940: 7)

Adams' (1989: 22) comment that there are effectively "two more-or-less separate histories of irrigation to be written in Africa" could be extended to apply to African agriculture more generally, with the first history comprising local approaches to resource management such as the examples of intensive agriculture summarised above, whilst the second consists of the history of colonial and post-independence agricultural interventions and includes the establishment of market-oriented settler farms and the construction of large-scale developments such as dam construction projects and irrigation schemes. As one might expect from the discussion in the preceding chapter, this second history is better understood than the first (see, for example, Barnett 1978 and Gaitskell 1959 in reference to the Gezira scheme, Sudan; Adams and Anderson 1988: 529-530, Anderson 2002, Chambers 1973 and Little 1992: 163 for the Perkerra scheme, Kenya; McCann 1981 for the Tana Dam, Ethiopia; Adams 1996 and Kipkorir 1983 for the Endo Scheme, Kenya) and, in consequence, advocacy of the use of local knowledge in the planning and implementation of developmental initiatives (for example UN 1993; World Bank 1989, cited by Mackenzie 1993: 1) is as much a response to the poor social and environmental record of former interventions, as it is an assessment of the success and longevity of local adaptations (Adams 1992; Adams and Grove 1984).

Nevertheless, whether development is sought via 'betterment', 'modernisation' or through the extension or adaptation of 'traditional' agriculture, conclusions as to the most effective course of action rely on conceptions of the long term efficacy and sustainability of local techniques and contain, therefore, either comparisons between the history of indigenous cultivation and the history of previous interventions, or comparisons between the history of African agriculture and the agricultural history of the developed world. If archaeological techniques can be used to inform these comparisons then they clearly have the potential to contribute to developmental debates. However, whilst the complexity and rate of change evidenced within African intensive agronomies challenge the validity of aspects of the general models outlined above, this same complexity and dynamism highlights the difficulty of reconstructing such systems archaeologically. The aim of the current chapter is therefore threefold: to highlight those factors that tend to be underemphasised in models of agricultural change; to examine the applicability of such models in the light of these factors; and to assess the archaeological visibility of these social and economic dynamics.

Given that the position here is that many of these factors are extremely difficult to discern archaeologically, the discussion will focus on ethnographic and historiographical data pertaining to indigenous African intensive agronomies, with the majority of case studies drawn from east Africa. However, since the social and economic complexity of these agronomies is often most apparent where the two histories of introduced and indigenous agriculture converge, the discussion will also draw upon studies that explore the impact and local perception of colonial and post-colonial agricultural interventions. Attempts by colonial authorities to learn from and utilise indigenous agricultural or horticultural techniques (for example Richards 1985; Anderson 1984; Grove 1987) may represent the most obvious examples of this convergence, but other periods of disruption and transition also serve to highlight the extent to which economic activities are embedded within social and religious institutions. As such, the dynamic and complex nature of local agronomies is also illustrated where interventionist policies impacted upon local systems of tenure or resource allocation (Adams 1996; Feierman 1990); disrupted local access to resources (ibid.); substantially modified the local environment (Adams 1990; Adams 1992; Adams and Grove 1984; Hughes 1984; Obeng 1978); or involved the resettlement of communities (Barrow 1981). However, this intersection between the two apparently separate histories of indigenous and introduced agriculture is equally evident where members of African societies employed or adapted pre-existing 'traditional' institutions to profit from emerging labour and commodity markets (for example McCann 1990; see also pp. 108-9 above), with early colonial examples serving to reinforce the case made above that modern African agricultural communities cannot be regarded as pristine survivals from a precolonial past.

By highlighting the extent to which economic, political and religious factors may be inalienable within indigenous African agronomies there is a danger, however, of exaggerating the differences between African and western agriculture, and indeed historically the apparent separateness of indigenous and introduced approaches to African cultivation has been emphasised by not comparing like with like. Thus, whilst various late nineteenth-century observers drew favourable comparisons between the living standards of African agronomists and that of the European rural working class (see, for example, Koponen 1988: 293, 369, 372-3), colonial settler farmers in Africa tended to see and present themselves not as members of a rural peasantry but as gentlemen land-owners (Ranger 1983: 213) and, as such, are likely to have viewed the traditions of European agricultural workers and those of African farmers with similar levels of scepticism. Moreover, and in contrast to the view expressed by Fortes and Evans-Pritchard above, it would be a mistake to see the distinction between indigenous and introduced agriculture as equating to a difference between subsistence and market-oriented approaches. Even from the brief summary of African intensive agriculture presented in the preceding chapter, it is clear that several communities (for example those in the Pare and Usambara mountains) could be said to have been involved in commodity level production prior to the colonial period, whilst the speed with which other societies adapted to emerging markets demonstrates that there was nothing inherent in the social organisation of these communities that acted to limit involvement in commercial exchange. Indeed, it is questionable whether those communities with pronounced social hierarchies (the Chagga chiefdoms, Shambaa, Ugweno, Usangi, for example) should be regarded as simply subsistence-based when it is evident that the elites within these societies enjoyed a standard of living far above that of mere survival.

Approaching this issue from the opposite direction, it is also apparent that not all colonial or post-colonial interventions were focussed towards establishing market production. Adams and Anderson (1988: 530) note, for example, that the Perkerra irrigation scheme near Lake Baringo, Kenya, was originally instigated in the 1930s with the aim of providing increased food security for the local population, but was later shifted towards the production of cash-crops for urban markets in an attempt to justify the project's high construction costs. Similarly, Beinart (1984) argues that the adoption of erosion control schemes in southern Africa from the 1920s onwards was partially a result of lobbying by white settler farmers, and that the settlers' principle concern was not soil conservation on their own land but was instead intended to increase the carrying capacity of land held by local communities thus freeing more territory for white-owned commercial farming (though see also Anderson 1984: 329-330 for a contrary view of the South African situation, and for a discussion of settler approaches to soil conservation in Kenya in the same period).

To paraphrase Mackenzie (1992: 1), the history of intervention in local agronomies could thus be characterised as being a matter of 'politics' rather than 'policies'; a point that is aptly illustrated for the colonial period by comparing the measures undertaken in settler dominated parts of British-ruled eastern and southern Africa, with the policies enacted to cope with a very different rural demographic situation in India (Grove 1987). Whilst both Beinart (1984) and Anderson (1984) stress that pragmatic political decisions of this sort represent only part of an equation which must include reference to broader narratives regarding environmental management and be understood in the context of the local and international economic situation, taken together these factors draw attention to the political elements within, or at least the potential political use of, several of the general models outlined above. This is perhaps most obvious in reference to the relationship between neo-Malthusianism and the approaches advocated by the so-called radical-ecologists which aim to limit the environmental impact of future developments by constraining consumption (Paterson 1994: 228 citing Bookchin 1980 and Gorz 1980), whilst broader ideological imperatives are self-evidently invoked at an international level by the Marxist stance at the heart of dependency theory (Baran 1957; Frank 1967; for a summary see Ruccio and Simon 1988), and at a national level by, for example, the socialist development plans undertaken in post-independence Tanzania. However, a similar case could be made for Boserup's (1965; 1981) expansionist stance, since despite its apparently anti-Malthusian premise that the environment is ultimately crisis free owing to the impossibility of overstating the ability of societies to overcome shortages through technological improvement, this emphasis on technology effectively dissolves the commonly held Malthus/Boserup opposition (Evans 1998: 85-6, 225; see also Netting 1993: 278-9), while the assertion that unrestrained free-market capitalism provides the most conducive environment for this necessary innovation demonstrates a political dimension akin to the anti-socialist standpoint of the Modernisation school (Rostow 1960; Gregory and Altman 1989: 35).

It is perhaps unsurprising, therefore, that Boserup's thesis gained favour at a time when approaches to economic development could be summarised as having rejected the reliance on 'customary' institutions that characterised indirect colonial rule in favour of promoting the establishment of specialised, and often mechanised, agricultural projects in selected areas whilst implementing tenure reforms in 'traditional' agricultural communities (Berry 1993, particularly chapter 1; Woodhouse, Bernstein and Hulme 2000a: 3-9). Thus, tenure reforms designed to promote private ownership such as the Swynnerton Plan in 1950s Kenya or the 'structural adjustment' polices supported by the IMF and World Bank from the 1980s onwards (Woodhouse, Bernstein and Hulme 2000a: 9-12), correlate well with a model that sees the adoption of permanent individual land rights as an inevitable consequence of increasing agricultural intensification (Feder and Noronha 1987; Tiffen 1996 citing Boserup 1970; see also Hardin 1968). Yet in the same year that Boserup's model was published, Herskovitz (1965: 343 cited in Shipton 1994: 249) commented that "the variety of forms of land tenure that exist at a given time among a people is seldom recognized", and indeed this diversity is certainly evident within the intensive agricultural communities summarised above (see, for example, S.F. Moore 1986 in reference to Kilimanjaro). Moreover, despite what was arguably the first attempt at an applied anthropology, the appointment of ethnographers by colonial authorities to record and codify customary laws of ownership in the 1940s and 1950s (Kuper 1996: 105 and 114; Shipton 1994: 349) did not prevent the introduction of agricultural schemes that conflicted with local approaches to property rights.

The compulsory construction of *matuta* ridges of the 'pit-cultivation' type (see p. 97) enforced by the Usambara Scheme between 1950 and 1957, for example, disrupted a Shambaa institution whereby landless individuals were lent plots for subsistence cultivation, since the raising of ridges were seen locally as constituting an enhancement that would confer rights of ownership on any individual who improved and then cultivated land for more than a year (Feierman 1990: 169-185).

However, of equal significance from the perspective of the current study, this same example also serves as a further illustration of the degree to which local political institutions, cosmological conceptions and systems of resource allocation are frequently inextricably interlinked. The connection in this instance, as noted above, centres on the relationship between political authority and an ability to produce rain; an association that manifested itself during the period of the Usambara Scheme through a conceptual link between water conservation techniques and rainmaking (Feierman 1990: 175), and which meant that protests against the enforced construction of ridges tended to be directed towards rainmakers, or couched in terms of the loss of rainmaking ability through association with foreigners (Feierman 1990: 171-2, 190; see also Maack 1996 for a discussion of similar protests in the Uluguru mountains, Tanzania). Nevertheless, conceptual connections of this type have long been understood and even appropriated by external agencies, as is evidenced through the missionary use of rainmaking symbolism in reference to the construction and maintenance of irrigated gardens in southern Africa during the late nineteenth century (Endfield and Nash 2004; see also Grove 1989, 1995).

Concluding a review of the various approaches to human ecology from an archaeological perspective, Patterson (1994: 229) acknowledges the need to give adequate weight to these social, ecological and cosmological factors, and thus argues for the employment of a Realist approach to study the totality of any given society's subsistence strategy as an integrated whole. The position here is similar, although with the relativist amendment that what is interesting from the point of view of the humanities is both these totalities themselves and how they are perceived and conceptualised by the communities that operated them. Understanding these interconnected factors requires a multi- or inter-disciplinary approach of the kind referred to by Shipton (1994: 347) as a 'new promiscuity' between research agendas that prioritise symbolic and ecological factors, since such a combination is necessary to recognise that "religion, ritual, and cognition, on the one hand, and adaptation, sustenance, and production, on the other, cannot be kept pure of each other" (ibid.).

An ethnographic critique of the generalised models

> Through living in a particular social and ecological environment over time people develop a known repertoire of strategies which become part of customary knowledge, socially maintained as a resource and predictably mobilized when the need arises. The mediation of seasonal income and daily needs entails a whole system of culturally and socially buttressed practices.
>
> (Guyer 1987 cited in McCann 1999a: 277)

Of the examples of African intensive agriculture summarised above, the communities that appear to best fit the suggested models are those of the Koyfar of Nigeria and the Dogon of Mali, the former of which has been cited as an example of intensification and disintensification in periods of increasing and decreasing population density (Netting 1968, 1993: particularly chapters 2 and 9; Stone 1993, 1996), whilst the latter has been referred to as a clear illustration of the applicability of the siege hypothesis (Kassogué et al. 1996), and thus also of population-push intensification and of ecological marginality and social isolation. In terms of geographical location, these two communities fit, or fitted, many of the criteria of the outlined models, the Koyfar having developed intensive techniques on the densely populated Jos Plateau (Netting 1968) before adopting more expansive practices after migrating into the Benue Valley in the mid twentieth century (for a summary see Netting 1993: 267-9), while Dogon villages are situated on the scree ('falaise') of the Bandiagara escarpment in Mali with defensive retreat positions situated on higher ground. For the Dogon, this choice of location was partly due to the slightly greater availability of water here than on the surrounding plains, but appears to have mainly acted as a defensive response to slave raiding during the fifteenth to nineteenth centuries, initially by the Songhai Empire and latterly by the Mossi, Fulani and Sao (van Beek 1993). In order to be within easy reach of the relative security of the habitation sites, fields were cultivated as close as possible to the falaise. This led, in turn, to an intensive use of these local fields with manuring used to maintain soil fertility for the primary staples of sorghum and millet (indeed the Dogon distinguish between the differing properties of eight types of manure; see also Catt 1994 and Woodward 1994 for a discussion of this sort of agricultural knowledge for medieval and post medieval Europe) which itself functioned to effectively import nutrients into the more intensively cultivated areas by grazing stock off-farm and then accumulating manure in the core areas of arable cultivation (see also Harris 1999 in reference to similar practices in Nigeria). Soil nitrogen levels are also maintained by rotating the staples with leguminous crops such as beans. Maize, onions and tobacco are also grown, the latter through a system of pot irrigation (Kassogué et al. 1996; van Beek 1993). Despite being time consuming in terms of processing and preparation, fonio is also grown as it is both a delicacy and a crop of significance in Dogon cosmology – indeed the universe is said to have emerged from a fonio seed (Board on Science and Technology for International Development – henceforth

BOSTID – 1996: 59-60). This religious role is reflected in the consumption of the crop during ritual or ceremonial occasions and may account for its incorporation in smelting processes as a clay temper (Huysecom and Agustoni 1997). Nevertheless, van Beek (1993) notes that fonio is now grown very little but argues that its significance in rituals suggests that it formerly played an integral role in the agricultural strategy.

The extent to which the Dogon are prepared to farm marginal land intensively is succinctly summarised by van Beek and deserves to be quoted at length:

> When water is trapped behind a barrage, the Dogon have the immediate border of this small lake to cultivate. Often this is just naked rock. From kilometres away they bring in soil to lay on the rock. Then small stones are sought, cut and lined up in order to mark out the cultivation squares. Manure and fertilizer are added to the soil, and finally the [onion] bulbs are planted. Then the actual work starts, watering the fields by carrying pots or calabashes from the well or lake to the field, each full morning for three months. It is a Herculean task, but one deemed normal for the Dogon.
>
> (van Beek 1993: 55)

Thus, the topographical location and techniques of cultivation appear to confirm the generalisations frequently applied to such systems: geographically Dogon settlements are isolated and occupy agriculturally marginal land which requires labour intensive methods of cultivation, whilst fear of slave raiding led to a situation where the community was also socially isolated and could thus be reasonably described as introverted and 'under siege'. Furthermore, the applicability of Boserup's thesis was apparently confirmed in the mid-twentieth century when increasing involvement in cash cropping led to the traditional systems of social and economic control breaking down, permitting rapid population rises. Van Beek cites demographic figures of 100,000 at the turn of the twentieth century rising to 300,000 in the early 1970s, which, as the Boserupian (and to a certain extent, Malthusian) model predicts, led to the shortening of fallows and hence soil depletion in the areas closest to the settlement sites. However, these sharp population increases were partially accommodated through expansion into the surrounding plains, now no-longer restricted by external pressure. Moreover, since the Dogon apparently regard virtually all land as 'usable' but make rational decisions about its practical 'manageability' (van Beek 1993), this case study appears to offer support for a further common generalisation regarding African agriculture, that there is no shortage of land in Africa, only a shortage of people to work it (Goody 1971; Koponen 1988: 221, 240, 302).

However, a factor of considerable significance to van Beek's analysis is that although the human restrictions to cultivating the plain were removed, the area remained cosmologically dangerous. A sharp opposition between the village (*ana*) and the bush (*oru*) was maintained, with the latter cultivatable but ultimately untameable by virtue of being inhabited by spirits, witches (*yadugona*) and sorcerers (*dudugona*). In other words, there is an archaeologically invisible factor, however apparently functional in origin or effect, that influences the choice of habitat and mode of resource exploitation. This observation highlights that the community lived within, and responded to, a 'perceived environment' (van Beek 1993 citing Hardesty 1978) which in turn serves to illustrate that ecology alone cannot explain the adoption of a particular subsistence strategy; a point noted by Håkansson (2002) who observes that the east African communities that employ irrigation are situated in both high rainfall and low rainfall areas (the former including Kilimanjaro, Pare, Usambara, Taita and Arusha, whilst the latter include Sonjo, Engaruka, Chamus and the Kerio Valley communities). Similarly, thinking in terms of the environment from a local perspective emphasises the truism that the Dogon were not isolated from the resources they themselves required and utilised, and that assessments of the agricultural marginality of the local resource-base relies on comparisons with more productive areas to which the community had no access, and of which the community had no experience.

As with Börjeson's (1999 and 2004) assessment of the applicability of the siege hypothesis in reference to Iraqw, therefore, the continuance of intensive practices in the core Dogon settlement areas following the removal of restrictions to expansion does not closely fit the suggested model. Indeed, although the Koyfar initially adopted slash-and-burn agriculture after migrating from the Jos Plateau and thus disintensified production as population densities decreased, even proponents of the Bosrupian model accept that correlations of this kind risk falsely homogenising the behaviour of individual communities (for example Stone 1993: 77; Stone comment to Morrison 1996: 601). Yet as Stone then stresses, it is wholly unrealistic to criticise models (specifically Boserup's) for failing to account for factors unique to particular case studies when this homogenisation and simplification is an inevitable consequence of the process of categorisation upon which models are built. Moreover, such a criticism would effectively act as a condemnation of both political economy and neo-classical economics, the latter of which has generally be characterised by an openness regarding the lack of empirical accuracy in its assumptions, and has tended to prioritise prediction over retrospective analysis to the point where Friedman (1935 cited by Gregory and Altman 1989: 26) was prepared to assert that "the more significant the theory, the more unrealistic the assumptions" and thus "to be important [..] a hypothesis must be descriptively false in its assumptions". Yet, this is a somewhat contradictory position for proponents of the population, siege, isolation or political centralisation models to take, given that they are apt to cite specific case studies in defence of these schemas (Koyfar in the case of Netting 1968 and 1993, and Stone 1996; Machakos in the case of Tiffen 1996; Engaruka in the case of Sutton 1978; Iraqw in the case of Gourou 1991 cited by Widgren 2004 and Börjeson 2004; Pokot in the case of Wittfogel 1957: 166). In doing so, this recourse to empirical ethnographic or historical case studies demonstrates a reliance on reconstructions of the history of intensive agriculture and indeed Boserup (1981: chapters 4 and 5) occasionally employs archaeological examples in this way. Once again, therefore, an ability to employ archaeological techniques to either support or refute these models in specific instances would clearly have an impact on developmental narratives that reference these models, but the presence of archaeologically invisible factors would seem to limit the extent of the discipline's possible contribution.

This is not to say, however, that the effects of these archaeologically obscure factors cannot be approximately accounted for by functional (and effectively functionalist) reconstructions. Thus, the reluctance of Dogon individuals to fully exploit the opportunities for more expansive forms of agriculture afforded by the cessation of 'siege' conditions may be explained by the presence of harmful forces in the plain, but may also be accounted for by more generalised observations such as "the stubborn persistence of habits and culturally valued behaviour" (Netting 1993: 267). Ignoring for now the potential negative connotations contained within terms like 'stubborn', this latter position is sufficiently broad to encompass a variety of effects including the possibility that communities, or individuals within these communities, may feel that they have a vested interest in resisting change because of investments in 'landesque' (Brookfield 1984; Blaikie and Brookfield 1987; Widgren 1999, 2000 and 2004) or 'symbolic (political/religious) capital' (Bourdieu 1990; Håkansson 1998 citing ibid.). Nevertheless, arguments along these lines represent an acknowledgment of the potential significance of the kinds of institutional factors that the general models may dismiss as externalities. Moreover, broadening (or mistranslating – Dalton 1969: 67) economic concepts to argue that these externalities can be seen as 'rational' in the sense that they 'maximise' some other factor (prestige or power, for example) is, to use the terms employed in the preceding chapter, to engage in the construction of plausible, rather than accurate, models.

Nevertheless, if one imagines an archaeological example akin to Dogon, or treats Dogon as an ethnographic parallel for an abandoned agronomy like Engaruka, failure to identify the cosmological or social institutions that limit the exploitation of a particular resource need not impair the functional validity of the resultant historical reconstruction (assuming that the lack of a physical or ecological constraint could be discerned archaeologically). However, a failure to identify the management strategies employed by the community would represent a serious weakness in terms of an archaeological contribution to developmental narratives.

Indeed, central to van Beek's (1993) hypothesis is that the entire foundation of the Dogon epistemology is focussed towards the practical *techne* of successful environmental manipulation which was itself intimately integrated into a social structure. This structure, it is argued, was 'designed' to 'nationalise' labour and individual knowledge and thus ensured that the expertise of the elder age set could be passed on to the next generation whilst allowing successful innovation to be subsumed into the generalised strategy. This leads van Beek (1993: 59) to suggest that this passing on of local knowledge ultimately 'back-fired' following the colonial encounter, as it rendered the Dogon unable to cope with information beyond the community level; an argument very similar to that presented by Taussig (1980) for communities in Bolivia.

In essence, then, the position here is not that the general models of agricultural change have no interpretative or predictive value, but rather that they need to be tested on a case by case basis. Thus, whilst Netting (1968; 1993) has argued cogently for the validity of Boserup's model in the case of Koyfar (see also Turner, Hyden and Kates 1993: 401-9), the example of Dogon serves to illustrate that a correlation between population pressure and agricultural intensification tends, in this case at least, to underemphasise the importance of social factors that the model would regard as externalities. These factors include the kinds of abstract conceptions discussed in chapter 2 such as the local perception of the environment, the presence or manipulation of supernatural forces, and the role of religious practices and beliefs in the management of resources. However, relatively mundane resource management strategies such as crop rotations, intercropping, irrigation schedules, and practices to prevent loss of soil fertility, also present problems for archaeological reconstruction, not because crop repertoires or the practice of manure application cannot be discerned archaeologically, but because the intricacy of seasonal cropping, fallowing and manuring decisions cannot be precisely defined on the basis of material remains and would thus have to be inferred from ethnographic analogies. Moreover, the Dogon example further highlights the extent to which these abstract and mundane factors may be interrelated, as is evidenced by the cultivation of fonio as a crop that appears to have a ritual/religious rather than purely economic value, thus demonstrating that agronomies cannot be modelled purely in terms of the use, exchange or dietary values of the crops produced. These various factors and the relationships between them are worth exploring in slightly more detail.

Hierarchy, political organisation and the division of labour

> Generally, it holds in Ethiopia and elsewhere that methods of extensive land-use through increased production (usually because of population growth) may lead to soil fatigue and even desertification. The methods employed in southern Ethiopia, however, have allowed good harvests to be obtained continually on small areas. [...]
>
> Clearly, the rural populations understand natural processes to achieve 'ecological balance'. In this way a dense population has survived and thrived in this region. But the autochthonous agrarian system is at the same time an integral part of the whole culture, with all its social and religious implications.
>
> (Amborn 1989: 79-80).

As the above quotation makes clear, the terraced and irrigated agriculture system practiced in and around Konso (summarised above p. 94-95) is considered by Amborn to represent not so much a contradiction of, but an exception to, the Malthusian premise that prolonged intensive production will lead to resource degradation. Indeed, of the east African furrow systems reviewed in the preceding chapter, those of the Burji-Konso cluster would appear, on the basis of current evidence, to be the oldest surviving examples, with dates of inception at some time prior to the sixteenth century AD. As examples of the validity of the expansionist position that resource degradation can be avoided by technological development, these southern Ethiopian communities would appear, therefore, to be fairly definitive, yet as both Amborn and Watson (1999; 2004) stress, the soil and water management features upon which the Burji-Konso areas rely cannot be understood without reference to the social, political and religious structures that are employed in their construction and maintenance. Indeed, Amborn (1989: 82, footnote) notes that in the Dullay and Dime areas the agricultural system seems to have been permanently affected by casualties inflicted on the warrior age grade by the Ethiopian empire at the turn of the twentieth century, and that in the latter of these two areas the terraced fields are now employed simply for slash-and-burn agriculture.

As among the Dogon, Konso agriculture is probably best characterised as an integrated, generalised economy and, again showing close parallels with Dogon, agricultural production is integrated within a three age-set social structure, here comprised of a 'warrior' set who are responsible for defence and the building and maintenance of the terrace and irrigation structures; a farmer age-set; and a senior age-set who make complex cropping decisions which include not only times of sowing and harvest, but also decisions as to the proportions of intercropped species; the length of fallow cycles, and the pairing of crops with those soils and locales that provide the best micro-climates. Moreover, through the authority to delay initiation and hence the rights of younger males to marry, the senior age-set can effectively place short-term limits on population growth in times of stress (Amborn 1989: 81). The social system could thus be broadly described as a gerontocracy, however, alongside the age-set system are territorial units (who operate reciprocal labour exchanges) and uni-linear decent groups (who organise the division of land) which together act as a system of checks and balances to prevent a single group gaining dominance (ibid.). In addition, there are also a series of communal labour organisations based on reciprocity or social obligation that function to assist land-holders in times of crisis, or at those points in the cropping cycle that require high inputs of labour (Watson 2004). Watson (1999; 2004) thus presents a case of considerable significance to the position adopted here, by arguing for the centrality within the social system of the hereditary male leaders of *poqalla* lineages. These lineage heads not only assign land and exercise influence over the mobilisation of labour, but also perform political and religious roles, suggesting a cosmological factor to a system that, even without this religious element, must be viewed as an inextricable combination of agricultural techniques and social processes. Van Beek's (1993) conclusion that the Dogon age-set system was functionally efficient at organising labour and at passing on agricultural knowledge is thus echoed by studies of other African intensive agronomies including those at Konso (Amborn 1989; Watson 2004) and Arusha, Tanzania (Spear 1997: 48), both of which also demonstrate the importance of religious or cosmological factors in the management of resources.

To say, then, that the construction of terraces or irrigation features requires some method of mobilising labour beyond the household level is to simplify a complicated situation, the complexity of which is evidenced by comparing the variety of labour organisations employed by different communities, or by noting the presence of several institutions of labour management within an individual society. Indeed, although the effectiveness of these institutions denies the validity of a simple correlation between centralised authority and an ability to command work (returned to in reference to Marakwet below), it could be argued that the existence of multiple methods of labour organisation within a single community correspond to a series of hierarchies that present individuals with several possible routes to increased social mobility. Sheridan's (2002) study of the social aspects of irrigated agriculture in North Pare, for example, notes that despite a degree of political centralisation focussed on the authority of chiefs, this authority was not employed to build or control the majority of irrigation structures (see p. 107 above) and instead mainly manifested itself through the control of trade via the charging of market fees (Sheridan 2002: 82); through the establishment of clients via initiations, political patronage and stock loans (ibid.); and through the extraction of harvest tributes for rainmaking and the appeasement of ancestors (Sheridan 2002: 82, 89; Sheridan 2004; see also Feierman 1990: 65 in reference to Usambara). Commoners, on the other hand, had (and have) the option of attempting to increase their social status through the accumulation of cattle via husbandry or bridewealth; through the purchase or clearing of additional land (Sheridan 2002: 85); through the productive advantages created by access to irrigation furrows, and through the creation of client relationships via stock loans or the establishment of *ndiva* reservoirs and furrows (Sheridan 2002: 87). However, as Sheridan stresses, the most obvious division of labour in North Pare society is sexual, and the most obvious route to commanding the work of others is marriage; a point that highlights the presence of hierarchies in even the most 'egalitarian' of acephalous communities, and which further demonstrates problems with applying market-oriented neo-classical economic calculations based on wage labour to economies that rely on unpaid household work (Chayanov 1966; see also Sahlins 1972 and Netting 1993 chapter 10).

Although Koponen (1988: 282) rejects as a colonial myth the notion that agricultural work in precolonial east Africa was exclusively a female activity, he notes nevertheless that the more "tedious" tasks were generally undertaken by women, and it is clear on the basis of the historical and ethnographic examples reviewed here that most societies included sumptuary restrictions that acted to limit the ability of women to accumulate wealth in their own right. This is not to say, however, that such institutions could not be circumvented or used to the advantage of female farmers, and indeed Sheridan (2002: 82) notes that women in North Pare avoided the proscription on female ownership of cattle by concealing their holdings through stock loans, and notes too that women retained a potent curse, the threat of which acted to ensure that they were not denied access to their allocation of furrow water (Sheridan 2002: 87). Yet despite considerable interaction between the various communities in the Pare mountains, particularly during the nineteenth and twentieth centuries (Kimambo 1969; Sheridan 2004), women in South Pare appear to have enjoyed slightly more autonomy and authority than their northern neighbours, with female elders involved in dispute adjudication and in political and ritual organisations (Håkansson 1995: 302; Håkansson 2003), whilst female farmers were not prohibited from owning cattle (ibid.) or from direct involvement in the management of irrigation furrows (Håkansson 1995: 305 citing Kotz 1922; Håkansson 2003). This contrasts markedly with the situation in North Pare where magical devices (*ifingo*) built into the walls of *ndiva* outlets are capable of injuring or killing women who take furrow water without the permission of the male furrow owner or manager (Sheridan 2002: 88).

Details of this kind might seem to be mere epiphenomena to local resource use strategies, but the organisation of labour can have dramatic effects on how agronomies are modelled and understood, as is evidenced by the unforeseen consequences of interventions into traditional management systems. Male control of commerce rather than subsistence based agricultural plots in Shambaa, for example, meant that as commercial cultivation expanded in the early twentieth century women's household subsistence plots became increasingly dispersed (Feierman 1990: 163). A similar effect appears to have occurred in North Pare where, in addition, systems of labour organisation and land tenure combined to influence settlement patterns since farmers often constructed irrigation features with the intention of attracting clients for both land and irrigation water (Sheridan 2002: 87-88); an observation that acts as a further case-based critique of models of agricultural intensification that view population pressure as a primary stimulus.

Whilst Sheridan (2202: 80) might be right, therefore, to assert that "Irrigation works were not just landesque capital that gave farmers' labor investments tangible form [...], they were also resources whose management inscribed the dominant ideologies of social inequality into the landscape", an archaeologist studying an agricultural landscape without recourse to the resource-use and cosmological information upon which the ethnographer relies would be forced to attempt to read this inscription from the opposite direction; a much more difficult proposition that would involve a reliance on ethnographic analogies with similar systems. Yet the level of variation evidenced from comparisons between closely related and often neighbouring communities raises the additional methodological concerns as to which analogy is the most appropriate, and as to how changes or continuity of practises would be discerned through time.

Complementary niche exploitation and inter-'ethnic' transitions

In addition to questioning the universality of the principles that underlie Malthusian and expansionist models of agricultural change, the above examples also call into question the impression that such systems are isolated and thus perhaps socially introverted and technologically conservative (Grove and Sutton 1989: 114-5). Indeed, even areas that might still be regarded as 'remote' such as Konso would seem to contradict the isolationist paradigm through their integration with pockets of specialist niche exploiters who maintained a level of symbiosis to the extent that "until the turn of the twentieth century this diversity had been sufficiently entrenched to allow each of the individual groups to pursue its unique system and to ensure its ethnic survival" (Amborn 1989: 83). Widgren's (1999, 2000) observation that among the case studies upon which he himself draws (Marakwet, Iraqw'ar Da'wa, Sonjo and Baringo) there is a common denominator in the form of a marked geographical division of labour, is thus perhaps a more useful generalisation, though here again it is noted that there is considerable variation between the cited examples with some communities specialising in intensive arable production whilst trading with neighbouring pastoralists (for which Widgren 1999: 11 cites Sonjo and Maasai, though see also Arusha and Maasai – Spear 1997 – or the Kerio Valley communities and the East Pokot – Bollig 1990), whereas in other societies (for example Iraqw – Widgren 1999: 11) exchanges of resources and products occur between members of the same 'ethnic' group. In this latter respect Widgren's argument echoes a suggestion made by Sadr (1991: 2-6, following Barth 1973) that divisions of labour within generalised or agropastoralist agronomies should be seen as a form of internal economic symbiosis, yet Sadr (1991: 3) stresses that the archaeological visibility of the sub-groups within these societies is likely to be extremely poor.

Problems of archaeologically determining such relationships accurately through material culture has been demonstrated by Hodder (1982) via an ethno-archaeological study of the interaction between the Njemps (referred to here by their Maa ethnonym Chamus) Pokot and Tugen, which illustrates that a reliance on differences in artefactual assemblages tends to exaggerate distinctions between communities, and was thus employed as part of a wider critique of culture-historical approaches in archaeology. Such a conclusion has clear repercussions for the current study since it would suggest that archaeological enquiries into the level of resource exchange between specialist agricultural communities may also fail to fully appreciate the level of inter-community exchange; an issue that is further exacerbated by ethnographic examples of migrations between communities operating complementary modes of resource use.

An example of this effect is evidenced among the terrace-using Fur (see p. 91) through the community's relationship with transhumant Baggara pastoralists (Haaland 1969 and McCown, Haaland and de Haan 1979). Resource competition between the two groups is (?was) minimised since the Fur cultivate mainly in the wet season when the proliferation of flies and leeches make the area inhospitable for Baggara stock. Trade is important in both economic and dietary terms, with the Baggara supplying milk and livestock, whilst the Fur trade agricultural produce, chiefly millet. Moreover, because the Fur also keep small numbers of cattle and need to minimise the risk to them during the rainy season, these are given into the care of the Baggara who incorporate them into their own herds, keeping the milk as payment. Since cattle constitute a method of 'capital' accumulation (Haaland 1969: 64; see also Paine 1971), wealthy Fur with between five to ten cows may chose to adopt pastoralism and live as a Baggara, whilst the reverse process is equally possible with impoverished Baggara applying to Fur communities for the usufruct right to cultivate land. These trade, stock-partnerships and emigration practices would clearly be extremely difficult, if not impossible, to discern archaeologically, and thus serve to further illustrate that it is not just local abstract conceptions that present problems of archaeological visibility.

With regard to trade, the ephemeral nature of the exchanged foodstuffs means that transactions of this kind are unlikely to leave clear traces in the archaeological record, whilst the presence of Fur stock in Baggera herds would obviously be impossible to see on the basis of faunal remains. Equally, since 'nomadized Fur' (Haaland 1969: 68) employ Baggara material culture and mimic the arrangement of Baggara tented camps (ibid.), it is unlikely that it would be possible to discern these inter-'ethnic' transitions on the basis of excavated sites or artefactual assemblages, despite the fact that successful transitions need not imply any change of identity, at least for the first generation (ibid.: 65). Haaland sees this maintenance of original identity as partially an issue of cultural heritage but as primarily due to a retention, or perhaps an initial inability to translate, differing conceptions of value (the use of differing 'value registers' in Guyer's terms – 1993). Clearly such conceptions cannot be accessed directly through archaeological data, yet the existence of numerous ethnographic and historical examples of transitions between groups operating complementary modes of resource exploitation would suggest that migrations of this kind also occurred in the prehistoric past. In addition to citing Haaland's study, Mace (1993: 369-370) notes similar processes among the Chamus in Kenya (citing Anderson 1988; see pp. 16-17 and 108 above) and the Fulani in Niger (citing Dupire 1972; see also Harris 1999), to which one might add the now infamous false dichotomy between the Tutsi and Hutu of Rwanda, the former of which were seen as Nilotic pastoralists and the latter as Bantu cultivators (Newbury 1988). As with the Fur and Baggara, the reality of these 'ethnic' identities appears to have been far more fluid with individuals able to cross the apparent 'caste' boundary presented by Maquet (1961).

Having established historical precedents for transitions of this kind, Mace (1993: 364) argues that they can be understood, and even predicted, on the basis of 'dynamic optimality models', themselves essentially derived from evolutionary optimal foraging theory. As one might expect from a model that draws upon schematic representations of animal behaviour – and accepting Friedman's comment cited above regarding the necessity of descriptively false assumptions in economic paradigms – Mace and her various discussants note a series of factors that the hypothesis treats as externalities but which nevertheless affect economic behaviour and thus also manifest themselves in decisions regarding changes in household or community subsistence strategies. Cronk (comments to Mace 1993: 374), for example, notes that the abandonment of a hunter-gather lifestyle in favour of pastoralism by the Mukogodo of Kenya in the early twentieth century (see p. 17 above) was prompted by a need to compete with the cattle bridewealths offered by various Maa speaking groups, for which a tradition of beehive bride payments had to be discarded. In Cronks (comments to Mace 1993: 374) words, therefore, "reproductive strategies are far from peripheral to an understanding of subsistence change", an argument which again raises the issue touched upon above in relation to the sexual division of labour, that there may be conflicts of interest within households that influence economic decisions, especially where different members of the household effectively pursue alternative strategies of resource exploitation (ibid. and Little, comments to Mace 1993: 376).

It is not the intention here, however, to argue pedantically for a level of methodological individualism that would effectively preclude any archaeological involvement in this area of study, since to criticise archaeology's inability to discern the decisions of individual actors would be to criticise archaeology in general. Nevertheless, economic choices made by individuals and households are significant in terms of the formulation of economic models and developmental policies, particularly those that emphasise community management. As such, it is necessary to recognise the differences in resolution afforded by different disciplines. From the perspective of the current study this means acknowledging that whilst the social complexity and temporal dynamism evidenced within the ethnographic literature may not be discernible in the archaeological record, this does not mean that the prehistory of these systems was any less complex or dynamic. Moreover, although the limits to archaeology's social and temporal precision may be well understood, it also needs to be acknowledged that lack of archaeological resolution in terms of individual decision makers may exacerbate limitations of temporal definition in archaeological enquiries and vice versa. Mace's (1993: 368) assertion that "the strategy that maximises long-term survival is not necessarily the same strategy that maximises short-term survival" acts to illustrate the potential importance of this point, especially if one adds to this equation that actors may make choices that prioritise either themselves, their household or their community.

Wealth, value, tenure systems and rationality

The question of scale also impacts upon attempts to model economic behaviour via recourse to rationality as a human universal, since even if one shifts the emphasis away from a formalist economic concern with exchange or material wealth accumulation to focus on social factors such as the maximisation of power, prestige, stability, or the minimisation of work or risk, the issue of potential conflicts between the interests of different societal sub-groups persist. Citing Boudon (1977) and drawing upon a hypothetical scenario offered by Rousseau where, despite the possibility of larger returns afforded by co-operative deer hunting, individuals nevertheless break from the hunt if opportunities to catch hares present themselves, Webster (1996) argues that actions that are rational at a sub-group level may appear irrational at a community or societal level. This point can be illustrated further by reference to an attempt by colonial authorities to improve and simplify the indigenous irrigation system at Marakwet, Kenya (see pp. 102-4), where in spite of favourable comments from late nineteenth-century travellers and early twentieth-century colonial officials, assessments from the 1930s onwards increasingly referred to the furrows as wasteful of water and labour; a conclusion that would seem to have not appreciated that the apparent duplication of work involved in furrow construction was a consequence of the interrelated systems of labour organisation and water allocation (see below). As with Rousseau's hypothetical example, then, assessments of the rationality of resource-use strategies are partly dependent on the scale at which these appraisals are made. Nevertheless, the perception that the agronomies within the Kerio valley could be improved and rationalised resulted in the establishment of the Endo Scheme in 1959 (Adams 1996; Kipkorir 1983: 6-7).

The project – more or less abandoned by 1963 (Adams 1996: 165) – involved the introduction of cash crops (chiefly chillies and bananas) and the realignment of furrows on the valley floor, for which farmers were to be charged per acre of irrigated land (Adams 1996: 164). Although the furrows on the escarpment were generally regarded as being well aligned, these were nevertheless seen as wasteful and inefficient since in some places several furrows draw water from the same source then follow similar courses and may even interweave before delivering water to adjacent fields (Soper 1983: 78). As with a later project in the Pokot area of the valley, local inhabitants generally resisted attempts to alter the management of the system (Kipkorir 1983), yet it is this same management structure that accounts for the apparent duplication of construction work as noted by Soper, because rights to furrow water are conferred by participation in furrow construction and maintenance (Adams 1996: 162-3; Adams, Watson and Mutiso 1997; Kipkorir 1983: 7; H. Moore 1983 and 1986; Östberg 1999, 2004; Soper 1983; Ssennyonga 1983; Watson 2004; Watson, Adams and Mutiso 1998: 76 and 82-3). Farmers were therefore not in a position to simply tap into, or pay for access to, pre-existing furrows, but could decide to organise or participate in the construction of an additional feature. Seen from this perspective, the changes proposed by the Endo Scheme with its emphasis on payment and centralised management would indeed seem to be a radical departure, whilst from the viewpoint of the various Agricultural Officers it was clear that the system was susceptible to rationalisation in that the level of labour and material expenditure involved in furrow construction and maintenance could be reduced without limiting the area under irrigation.

Of the two possible ways of theorising this behaviour cited by Webster (1996: 610-612), the concept of 'limited rationality' (that the apparently irrational actions of protagonists are a result of imperfect information – following Boudon 1977) is clearly inappropriate in the case of Marakwet because there is nothing irrational about organising labour co-operatively within clans, whilst the theory of 'supraintentional causality' (that acts which are rational for individuals may have unanticipated consequences that make them irrational for the group as a whole – Webster 1996: 611 citing Elster 1978; see also Giddens 1984: 13-14) would seem equally unsuitable since it is difficult to regard the level of labour and water consumption necessitated by the construction of multiple furrows as in any way 'unanticipated'. Nevertheless, Webster's (1996: 610) conclusion that "archaeologists have tended to underconceptualize the past by overrationalizing it" is relevant for the current study because it again raises the question of the archaeological visibility of social factors that are integral to the management of complex agricultural systems, in this case highlighting the problem that to assume that a community would have deployed its resources in a manner that maximises labour returns is relatively unhelpful without an ability to discern the nature of related institutions such as systems of labour organisation and social hierarchy.

In terms of the discussion presented in chapter 2, then, the management of the irrigation system at Marakwet did not appear irrational to external observers due to a conflict between the conceptions of causation employed by the community and those employed by colonial officials (see pp. 45-6), and neither did this impression of irrationality arise from the incorporation of 'superfluous' 'ritual' activities in the production process (see p. 56-58). Nevertheless, modelling economic behaviour may still rely upon an understanding of how the local community configured value, itself an abstract concept that resists a simple reduction to use-value, exchange-value or 'man-hours', especially in communities where individuals or sub-groups may pursue strategies that accumulate 'wealth' in different, and possibly non-exchangeable, forms (Guyer 1993). In other words, in the absence of 'all purpose' money (i.e. a single commodity authorised by the state and by reference to which all objects can be valued – Simmel 1978 [1907]) assessments of a given object's worth must be made by association to some other article or social relationship (Appadurai 1986; Cohen 1967; Kopytoff 1986; Miller 1987), the character of which may have a dramatic effect on economic models.

Håkansson (2002), for example, has suggested that the intensive irrigation using communities in precolonial east Africa all configure (or originally configured) value in terms of livestock, and has argued further that the initial incentive to intensify arable production was to produce crops that could be exchanged for cattle. This hypothesis is necessarily deductive, and indeed is somewhat speculative, since the decisions that are seen as underlying these communities' economic histories tend not to be recalled within the recorded oral historical accounts and, where they are, they may reflect more recent developments as has been suggested in reference to the Sonjo proscription on cattle ownership (Adams, Potkanski and Sutton 1994: 23; see p. 101) or, conversely, in relation to the Maasai prohibition on arable production (Broch-Due and Anderson 1999; Sutton 1993; Waller 1999). Indeed, even the Arusha who are culturally Maasai and who could be said to maintain a 'pastoral ethos' (Gulliver 1965; Spear 1993b, 1996, 1997) recall, in some traditions at least, that the original incentive for the commencement of irrigated agriculture was not the accumulation of livestock but was instead intended to effectively act as an arable arm of the plains Maasai (Spear 1997: 41; p. 109 above). Thus, in order to account for the continued existence of these agronomies and for the lack of out-migration by individuals who had successfully accumulated cattle, Håkansson (2002) is obliged to argue that maximum herd sizes were limited by the land and labour requirements of arable production; an argument that therefore regards these economies as quite unsuccessful in achieving their original ambitions. Problems of confirming this thesis through oral historical or archaeological enquiries notwithstanding, there remains the issue that ownership (if not necessarily the commoditisation) of land is a feature of several of these communities, as is evidenced among the Meru where land is inherited by the youngest son (Spear 1997: 26) and where political authority is partially based on inherited status as a descendant of pioneers, with the plots cultivated by these early immigrants the focus of respect and the location of ancestral shrines (Spear 1996). This link between 'heritage' (literally), cosmology, identity and landscape exists in marked contrast to a common pastoralist viewpoint that sees livestock as being owned but which regards the grazing and water resources upon which this livestock relies as being communal property, or as being ownerless and thus open to exploitation as required (Hardin 1968; Spencer 1998: 231).

Yet, of course, the situation is often more complex than this simplistic dichotomy between communities that configure value in terms of land or cattle would imply, both because of movements of people, techniques and ideas between these communities, and because, as noted above, individual societies may include several alternative or complementary hierarchies that configure value in different ways. Thus, as discussed in reference to the division of labour in North Pare, it is possible to see hierarchies of prestige (as opposed to 'status' conferred through ownership – Gregory and Altman 1989: 38 citing Weber 1948; see also Bourdieu 1984), wealth in cattle (as proposed by Håkansson 2002) and wealth in people (Meirs and Kopytoff 1977; Vansina 1990). Moreover, increasing involvement in trade with neighbours and coastal caravans throughout the nineteenth century would indicate an appreciation of the value others placed on ivory and slaves (Håkansson 2004: 567-571) and would suggest some level of production specifically for exchange with historical evidence indicating that these commodities included pottery, salt, iron and foodstuffs, all of which are likely to have been seen as possessing both use- and exchange-values.

Thus, although several of the communities cited by Håkansson (2002) clearly do configure value in terms of livestock and may even use monetary metaphors in reference to domestic animals (one of Loiske's – 1999: 45 – Iraqw informants expressing the association as "the goats are the coins [...cattle...] are the notes"), the existence of multiple ways of comparing values or accumulating wealth, and the relationship between these registers, are also evidenced through recent interviews ("it is better to be rich in cattle than having a lot of land or many ndiva [...] Ndiva owners and those that own a lot of land were not the same as big livestock owners" – informant from North Pare cited by Sheridan 2002: 87; "When water comes home it is a marriage. Whoever has a channel has a wife" – comment by a young Marakwet man comparing furrow 'ownership' to having livestock, cited by Östberg 1999: 31). Although, of course, these views cannot be seen as necessarily reflecting those of these individuals' forebears, they do at least demonstrate the level of diversity between communities, and serve to illustrate the range of variables that local farmers employ and react to when making what might be thought of as ostensibly economic decisions.

Crops and cropping strategies

As with the other areas of African agriculture discussed thus far, the issue of crop choices and cropping strategies cannot be completely divorced from related social, political and religious frameworks. The continued cultivation of what appears to be a crop of primarily ritual significance in Dogon (van Beek 1993) is evidence of this, as is the relationship between political and religious authority in the allocation of land and furrow water in Sonjo (Gray 1963: 127), since in deciding what crops to plant a farmer must be fairly confident that these will receive sufficient water to bring them to maturity, and must feel reasonably secure that the ground into which they are planted will remain in his or her control by the time of the harvest. However, if the presence of these culturally specific social factors present problems in terms of historical re-enactment, this merely exacerbates the already difficult task of reconstructing African palaeoeconomies that is created by the widespread practice of intercropping; the variety of locally developed variants of the primary African staples; and the impossibility of discerning fallowing regimes or irrigation schedules on the basis of material remains.

Considered by Richards (1985) to be one Africa's most important technical achievements and a major contribution to agriculture, intercropping – or the practice of planting a diverse range of crop species within a single field – presents obvious problems in terms of modelling agricultural systems, in that even if the range of exploited cultigens is known from historiographic or archaeological sources, the relative importance of each crop may be difficult to discern; a problem that is itself exacerbated by the likelihood that farmers will vary the proportions of species sown from season to season. Conelly (1994: 162), for example, notes the cultivation of six crops (sorghum, maize, cowpea, cassava, sweet potato and sugar cane) dispersed more or less evenly within a single lakeshore field (measuring approximately 44m by 160m of which roughly a quarter was under fallow) on Rushinga Island, Kenya, whilst even areas on Rushinga that are referred to specifically as grain fields are planted with a mixture of sorghum and cowpeas, or sorghum, maize and cowpeas (Conelly 1994: 160). Complicating the issue still further, the plants grown within intercropped areas need not all be edible, since although the advantages of interplanting include catch cropping (planting fast growing plants that when harvested will provide space for the slower maturing plants around them); using some plants to provide shade for others; mixing crops to provide disease or pest breaks; and combining nitrogen fixers with nitrogen users, these functions may also be served by fodder crops or by weeds, the residues of which can then be worked into the soil to act as green manure (see for example Amborn 1989: 78-9 on Konso and p. 95 above). In such an instance it would clearly be extremely difficult on the basis or archaeobotanical data to distinguish the complementary use of weeds from their unwanted presence, or to define the relative importance of the fodder species (Charles, Halstead and Jones 1998).

However, if the prevalence of intercropping in the agronomies summarised in the preceding gazetteer presents an obstacle to palaeoeconomic reconstruction, similar challenges are presented by agronomies that specialised, or appear to have specialised, in the production of a single crop. To take an exceptional but nevertheless relevant example, the range of growing and cropping characteristics displayed by different races and species variants of *Sorghum bicolor* act to highlight the difficulty of attempting to model agronomies on the basis of necessarily imprecise palaeobotanical evidence. Now a crop of world wide importance and, in terms of production volumes, the fifth major cereal crop after wheat, rice, maize and barley, sorghum forms the dietary staple for more than 500 million people; yielding in excess of 70 million metric tons of grain annually from approximately 50 million acres of land, of which roughly half are in Africa (United Nations, Food and Agriculture Organisation – henceforth FAO – 2004). The global production figure, however, was higher ten years earlier (FAO 1996). Although there are numerous variants that will be briefly summarised below, sorghum is an annual grass with varieties that grow to between 0.5 and 5m tall, with panicles that can be compact or open, erect or goosenecked; the latter an adaptation that may be related to storage in roof rafters (Harlan 1993). The crop is chiefly adapted to semi-arid environments with rainfalls in the range of 400-750mm per annum (Acland 1971; BOSTID 1996; FAO 2004), and is normally grown in an altitude range of sea-level to 1000m (FAO 2004), though certain varieties can tolerate altitudes up to 2400m as in the Kigezi Highlands in Uganda (Acland 1971 and CGIAR 2004). Of the agronomies summarised in the preceding chapter, sorghum is or was an important staple for the Dogon, Mursi, Turkana, Iraqw, and Sonjo, and forms a significant role of the economies in the areas of the Burji-Konso cluster, the Kerio Valley, Rushinga, Mfangano, Ukara and Nyanga. It is also the only crop attested to by archaeological evidence at Engaruka.

Although the earliest dates for domesticated sorghum are from India (Harlan 1993 citing Kajale 1988; Young and Thompson 1999), the crop's wild progenitor is African in origin, demonstrating that the time of introduction into India of around 2000 BC represents merely a date after which it had been domesticated in Africa (Harlan 1993 citing Rowley-Conwy 1991). Of the various wild races, *verticilliflorum* shows the closest similarity to the earliest domesticated forms in terms of ecological preferences, distribution and morphology, leading Harlan (1989 and 1993) to argue that the crop was probably first domesticated in the Sudan-Chad area. However, the ease with which domesticated sorghums hybridise with wild and other cultivated species without loss of fertility make it difficult to distinguish definitively between 'pure' wild forms and crosses of wild and cultivated species (Harlan 1993 and BOSTID 1996). Nevertheless, Harlan and De Wet (1972) present a simplified classification containing five primary races: *bicolor* (morphologically the closest relation to the progenitor and widespread throughout Africa); *guinea* (a west African, higher rainfall adaptation, also grown in the east African highlands); *caudatum* (mainly cultivated between Lake Chad and the Ethiopian border, as well as in Uganda); *Kafir* (a southern African variant), and *durra* (apparently a derived version of *bicolor*, developed in India and returning to the east Africa coast through Islamic trade). Although this broad race classification is useful in terms of reconstructing the long-term history of the crop, sorghum's ability to produce viable hybrids has resulted in a large number of further sub-categories (BOSTID recognise 31 sub-species, 157 varieties and 571 cultivated forms – 1996: 142). These varieties and forms are the result of local adaptation and reflect a wide range of selective pressures based on environmental conditions and social and cultural preferences.

Sorghum's principal advantages over other cereals are its drought tolerance and its ability to withstand short periods of waterlogging (Acland 1971, FAO 2004 and Harlan 1989 and

1993). The crop's resistance to drought is bettered only by pennisetum and relies on several low rainfall adaptations including a well branched root system comprising nearly twice as many roots as maize (Acland 1971); high levels of silica in the endodermis that may prevent root collapse in dry soil (ibid.); an ability to reduce transpiration by rolling its leaves; and possibly also by closing the stomata, an action that effectively slows its metabolic processes to near dormancy whilst allowing rapid recovering following further rain (Acland 1971 and BOSTID 1996). Being tolerant to both drought and brief floods make it well suited for cultivation that capitalises on either unimodal or bimodal rainfall distributions, with sowing either during or shortly after the rains. The crop is then capable of maturing using residual soil moisture, and can be harvested, dried and stored during the dry period that follows. Indeed, the crop's ability to survive short periods of waterlogging make it suitable for *decrue* farming (see, for example, Connah 1985 in reference to the Firki planes, Nigeria; p. 89 above) with certain varieties that are grown in the Niger inland delta so tolerant to inundation that they are harvested from canoes (Harlan 1993).

As noted, the potential for farmers to select those characteristics that best suit the local conditions is itself a major advantage of the crop, however, the selection criteria go beyond adaptation to local hydrological regimes and the maximisation of yield. Taste is one obvious factor, with Acland (1971) noting that white-seeded varieties are preferred for *ugali* or *uji*, whilst brown-seeded forms are generally more bitter and are thus employed in brewing. Where brown-seeded varieties are eaten, as in the Kigezi Highlands, grains are encouraged to germinate prior to grinding in order to increase the sugar content (Acland 1971). However, the selected characteristics may not be as immediately obvious as taste: BOSTID (1996) note, for example, that attempts to introduce 'improved' sorghum varieties to west Africa were rejected because the *toh* they produced did not retain the required texture overnight. Harlan (1993) illustrates a similar point by reference to parts of Mali where both hard- and soft-seeded varieties are grown, the former having better resistance to insect attack in storage but are more difficult to pound. The soft-seeded forms are therefore consumed early, whilst the hard-seeded varieties are saved and stored. Other selected characteristics include early root or tiller development (to maximise use of available water following rains); tall plants (lowering the crop ratio but maximising stalk length for use as fodder, building material or fuel); short growing cycle (to maximise number of crops per season; see, for example, Morgan 1974: 85 in reference to Turkana); long growing cycles (to make best use of soils of low fertility); and resistance to pest and parasites (BOSTID 1996).

As the Malian example cited above illustrates, communities often grow a range of varieties in order to exploit different storage characteristics, localised micro-climates and soil conditions, or as a method of coping with fluctuations in year by year conditions such as late or early rains. In Sukumaland, Tanzania, for example, over 100 named cultivars have been identified, whilst in the area surrounding Lake Turkana in Kenya a huge array of distinctly coloured variants are grown, with farmers claiming to be able to distinguish between the grains and who grew them. This, it is argued, avoids theft (BOSTID 1996). However, this level of variation is impossible to distinguish on the basis of archaeological evidence such as charred grains (Harlan 1993). In consequence, it would be extremely difficult to accurately model even relatively simple agronomies without information regarding the particular characteristics of the specific crop varieties employed, since to do so would require knowledge of the water requirements and yields of specific cultivars; the range and proportions of crop species grown; the total area under cultivation and the percentage of this area under fallow; an understanding of past environmental conditions and, in the case of many of the agronomies discussed here, an indication of the quantities of water available to irrigation systems and an appreciation of how that water was allocated within furrow networks.

Summary: the general versus the particular

> Recent surveys of environmental history [...] have been at pains to point out what a complex, multifaceted reality the environment is, comprising as it does the natural order, the economic means by which people exploit that order and the social and political means by which they organise that exploitation. Given that all these elements are socially constructed – not least ideas concerning 'nature', 'order' and 'economy' – they are also deeply embedded in cultural values and beliefs which, in turn, make them appear 'natural'.
>
> (Spear 1996: 213).

By focussing on the problems with what are essentially deductive models of agricultural change by employing insights derived from inductively produced case studies, the intention has been to question the applicability of the general models of economic change and to highlight the diversity and dynamism within and between African agricultural communities. Thus, an examination of ethnographic sources serves to reinforce the historical critique that formed the conclusion to the preceding chapter by demonstrating problems with the models of agricultural intensification that emphasise environmental constraints, population pressure, political centralisation or social isolation. In addition, the level of detail afforded by the ethnographic sources emphasises the complexity of African agricultural systems and, in line with Spear's comments above, illustrates the degree to which economic practices are embedded within, and are inseparable from, other social institutions. This is not to say that the various theoretical frameworks that have been developed to account for agricultural change do not raise important issues and indeed, taken together, they highlight a series of extremely pertinent factors that would need to be considered in any attempt to model the development of intensive agronomies. However, by giving prominence to one or two of these factors, each model downplays the significance of culturally specific conceptions and institutions and thereby risks falsely homogenising a diverse range of local developments. If what is known of the history of intensive agriculture in Africa indicates the level of this diversity, then the ethnographic record serves as evidence that the historical picture is itself a simplification. Commenting on Mace's model summarised above, Anderson makes precisely this point, arguing that:

> The social and political constraints that may distort [the] predictive power [of a general – specifically Mace's – model] are likely to have been just as significant historically as they are in the present, although our ability to reconstruct their influence for the historical cases is severely compromised. Historical examples may therefore appear to fit the model rather more neatly simply because we know rather less about them.
>
> (Anderson, comment to Mace 1993: 372)

This, then, represents an alternative form of Schmidt's paradox (1995: 119; see p. 41 and 73-74 above) whereby an understanding of African history would seem to be a necessary prerequisite to the making of informed decisions regarding developmental policies, yet the task of writing this history is complicated, and indeed impaired, by the presence of factors within these agronomies that present barriers to historical re-enactment. As argued above, these include political, religious, epistemological and even relatively mundane factors which, individually and together, mean that it is difficult to imagine an historical analysis being able to confidently reconstruct agronomies in terms of yields or to accurately account for how a particular community thought about its response to changing conditions. As one would expect, this problem of re-enactment affects historiography and archaeology to differing degrees, but this situation is not as simple as suggested by Niemeijer (1996: 94) who – despite advocating what he describes as 'a new development paradigm' built around diachronic examinations of local resource exploitation strategies – dismisses any attempt to use archaeological techniques to discern social, political and economic factors whilst arguing that "environmental change is relatively easy to document through the study of sediments, lake levels, pollen analysis, and so on", and goes on to assert that "although this poses a clear problem in terms of prehistory, it is much less of an issue for the recent past". Such an assessment would seem to take an optimistic view of the temporal resolution of palaeoenvironmental reconstructions; ignores the extent to which different communities see and react to the environment in different ways; and assumes the written and oral sources will be sufficiently detailed to reconstruct agricultural techniques or to permit appraisals of the long-term sustainability of local practices (Niemeijer 1996: 103-105).

At present, however, the state of historical knowledge regarding indigenous African agriculture lacks this necessary detail, whilst the recognition that the African past is more dynamic than is often supposed neither supports nor refutes the efficacy or sustainability of local resource use strategies unless one takes the view referred to by Silitoe (1998: 225) as "extreme empowerment", whereby it is asserted that African farmers have long demonstrated an ability to experiment with and make informed decisions about the usefulness of available technology and should, therefore, be given access to these resources and allowed to design their own solutions (ibid. citing Chambers, Pacey and Thrupp 1989; Scoones and Thompson 1994 and others), or should be given indirect support by creating a political and economic environment that allows farmers the freedom to exercise this dynamic and adaptive behaviour (Niemeijer 1996: 102 and 106). As a footnote, however, Niemeijer (1996: 102) states, apparently without irony, that historically this "dynamic behaviour" includes "raiding, enslavement and genocide" which do not "warrant support" as they are "no longer acceptable on ethical grounds". Ignoring for now that there is no reason to single out Africa as a location for such activities, this statement does at least serve as a reminder that comparisons between historical case studies and contemporary practices never compare like with like, and that strategies that may have proved successful in the past may not be suited to the modern economic situation or to a period of unprecedented population growth and climate change. Similarly, since it is clear that the term 'indigenous knowledge' could refer to both technical solutions and to the social, political and even religious institutions that organise their management, previously effective techniques may prove difficult to replicate in small-scale rural societies in which customary hierarchies are coming under increasing pressure, and where individuals now have more opportunities to pursue alternative economic strategies either within their local communities or elsewhere (Carswell 2002; Conelly 1994; Murton 1999; Spencer 1998 particularly chapter 8).

Moreover, there is a danger that in reacting against a view of African agriculture as static and wasteful, this new paradigm will go beyond the level of respect for indigenous techniques shown by some early European observers (Grove 1988; Soper 1983; MacKenzie 1998) to present an image of African agronomies which is, historically at least, nostalgic and akin to that of Hopkins' (1975) 'merrie Africa' (Richards 1993). In so doing, the rhetoric of Agenda 21 (UN 1992) that calls for 'community based' resource management, when coupled with a re-awakening of interest in indigenous knowledge, risk simply repeating this alternative stereotype (Woodhouse, Bernstein and Hulme 2000). Yet even advocates of the idea that locally developed agronomies may act as models for the future of African rural development acknowledge the possibility that not all communities operate(d) strategies which conserve(d) resources. Indeed, despite arguing that precolonial agronomies in east

Africa were generally well adapted to their local environments, the site that forms the case study in the following chapter has been described by Koponen (1988: 383) as one of several "indigenous systems [that] had ended in a complete cul-de-sac", the implication being that Engaruka offers a rare example of the local mismanagement of resources, and thus perhaps serves as an indication of the Malthusian crisis facing other intensive agronomies in the region. As will be discussed in the next chapter, such an assessment is somewhat premature given the current state of knowledge regarding the system's operation and abandonment, but in reviewing the results of previous and recent archaeological research at the site it is possible to offer a more informed appraisal of the strengths and weaknesses of archaeological techniques in reaching an understanding of African agricultural history.

5

The Archaeology of Engaruka: an abandoned precolonial agronomy in north-eastern Tanzania

> On the African side the drought crises of the 1970s and 1980s, and the international publicity generated by famines, have emphasised the importance of trying not just to understand agricultural practice but also to consider it in its environmental, social and demographic context. [...] it has needed such crises and international concern to provoke cross-disciplinary Africanist discussion of an adequate scale and quality and to bring to attention, if only partially so far, the importance of historical perspective. The subject of 'ancient fields' and former agricultural techniques – for a while regarded as a peripheral if not downright antiquarian pursuit, one that had been discredited by over-imaginative claims of the remains of 'ancient civilisations' in 'remote' parts of Africa – has been given new relevance. Agriculture is work in the fields; the historical study of agriculture requires that we locate and reconstruct the working of those earlier fields.
>
> (Sutton 1989a: 10)

Having presented what might be regarded as a pessimistic appraisal of the feasibility of reconstructing African agricultural history on the basis of archaeological evidence, the aim of the current chapter is to explore those areas in which archaeological research can be employed to reveal aspects of local agricultural knowledge, and to assess the precision with which this knowledge can be placed within its temporal context. As noted above (pp. 98-99) the site of Engaruka is particularly well suited for this purpose, being the only well preserved and wholly abandoned intensive agricultural landscape in east Africa, with the remains of irrigation features and terraced fields thus presenting an opportunity to examine the stratigraphy and soils of an indigenous agronomy that have not be disturbed by later cultivation (Homburg 2002; Sutton 1991: 30; Sutton 2000: 211). With this opportunity, of course, come various disadvantages. These include the biases of preservation discussed by Farrington (1985: 5; see p. 77 and 82 above), as well as the site's uniqueness (Sutton 2000: 211) which may act to limit its potential as a direct paradigm for developmental initiatives, not least because the abandonment of the cultivation area would seem, superficially, to suggest that the agronomy at Engaruka was ultimately ill-adapted to its environment. The following discussion will therefore explore these related issues by summarising the findings of previous fieldwork at the site and by presenting the results of the two seasons of excavations and survey carried out for this project in 2002 and 2003. A brief summary of the results of the preliminary walkover and soil analyses undertaken in 2001 will also be presented (Stump 2003). The chapter is therefore not intended to act as a full excavation report as results that are not strictly pertinent to the fieldwork research aims will not be discussed in detail.

Site location, topography and geology

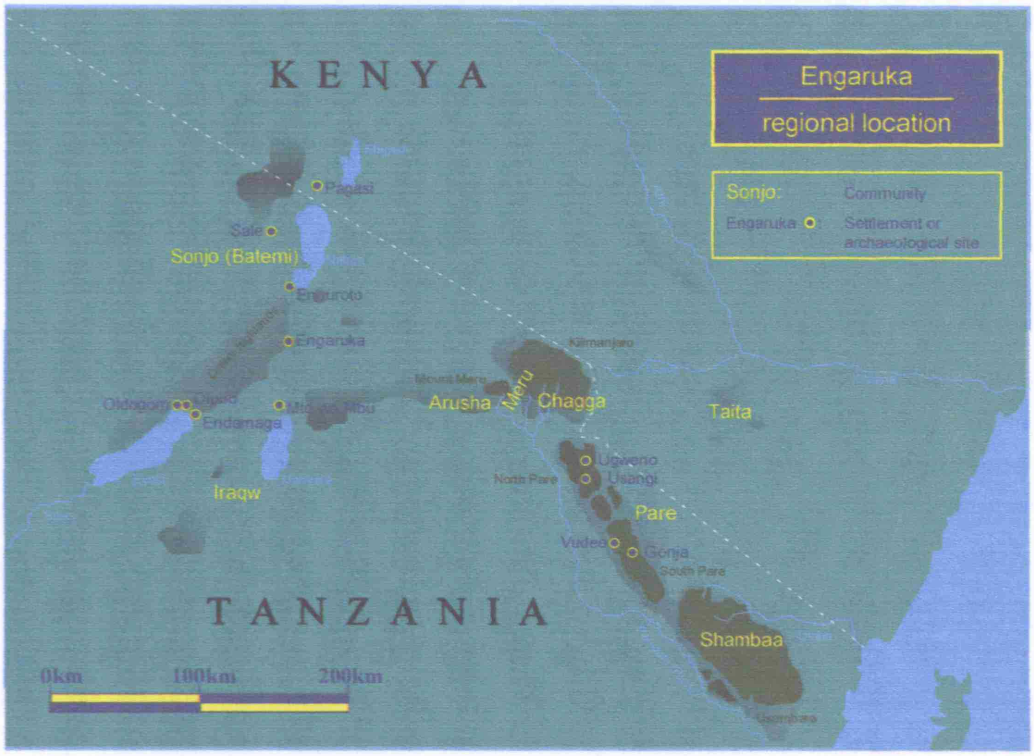

Figure 5.1: Engaruka, regional location

The site is centred at approximately 2° 59' S /35° 58' E, and is located to the immediate west of the modern village of Engaruka, in Monduli District, northern Tanzania. The site occupies, and clearly utilised, a dramatic change in the local topography where the Rift Valley floor meets the western wall of the Rift Escarpment. Settlement sites are located on the lower levels of the foothills of this escarpment, whilst the main cultivation area occupies the predominantly level plain below. The field systems that appear to demarcate the former area of exploitation extend for approximately nine kilometres along the foot of the valley covering an area of roughly 1800ha. The cultivation area slopes downwards from west to east, ranging in height from approximately 1000m to roughly 850m above sea level. The solid geology of the area is primarily igneous kainozoic neogenes. Soils are predominantly slightly loamy (or silty) sands of the kaolinoid type, though the area of former exploitation is crossed by a series of alluvial fans composed of relatively fertile andosols (Westerberg 2002). Vegetation levels vary but are perhaps best characterised as light savannah scrub or bushed grassland. Rainfall is bimodal (December and March-April), and currently averages roughly 400mm per annum, though precipitation levels in the river catchments on the crater highlands are typically between 800-1000mm per year.

Archaeological Site Description

A preliminary site report produced by Leakey (1936) divided the site into five areas which were designated as the North Ruins, the South Ruins, and the North, Central, and South Valley Ruins. The first two of these refer to the large groups of stone built terrace structures on the lower slopes of the Rift Escarpment and located on either side of the Engaruka river, whilst the other three refer to former cultivation areas, the first of which lies to the north of the Engaruka river, the second is located to the immediate south of this river, and the third is situated south of the Olemelepo stream. Of these three areas, the Central Valley Ruins were considered to be the most archaeologically interesting as it contains numerous stone cairns and substantially built stone circles, as well as low terraces and stone-lines that form rectilinear enclosures. Sassoon (1966) adopted a different nomenclature but largely retained Leakey's area-based groups. The North and South Ruins were renamed as 'the hillside structures' and were estimated to include at least 500 terrace platforms. Initially Sassoon thought these terraces were arranged into four or more nucleated habitation sites (Sassoon 1966), but in later work the escarpment features are discussed by reference to a further sub-division into seven hillsides, numbered from south to north (Sassoon 1967 and Robertshaw 1986). The three former areas of cultivation noted by Leakey are referred to by Sassoon as 'the northern field system', 'the main central area of cairns and stone enclosures' and 'the southern system of stone enclosures'. Although Sutton's subsequent survey work (1978; see also the summary presented in Sutton 2000 [1998] or 2004) has concentrated primarily on the identification of irrigation features and field systems below the escarpment, Sutton considers Sassoon's identification of seven 'village' sites to be correct. Sassoon's site division is thus largely retained in Sutton's work, though the reinterpretation of the site as the remains of an intensively cultivated, primarily arable agronomy, is reflected in a slight change of nomenclature that refers to the North, Central and South Fields. This later nomenclature is also employed here (see figure 5.2).

The dating and relative chronology of these various areas will be discussed in detail below, but in very general terms the site could be referred to as belonging to the Late Iron Age. On the basis of artefactual evidence and radiocarbon determinations the occupation of the site can be broadly dated to between the early fifteenth and the mid- to late eighteenth centuries AD (Robertshaw 1986; Sutton 2004 and Laulumaa pers. comm.)

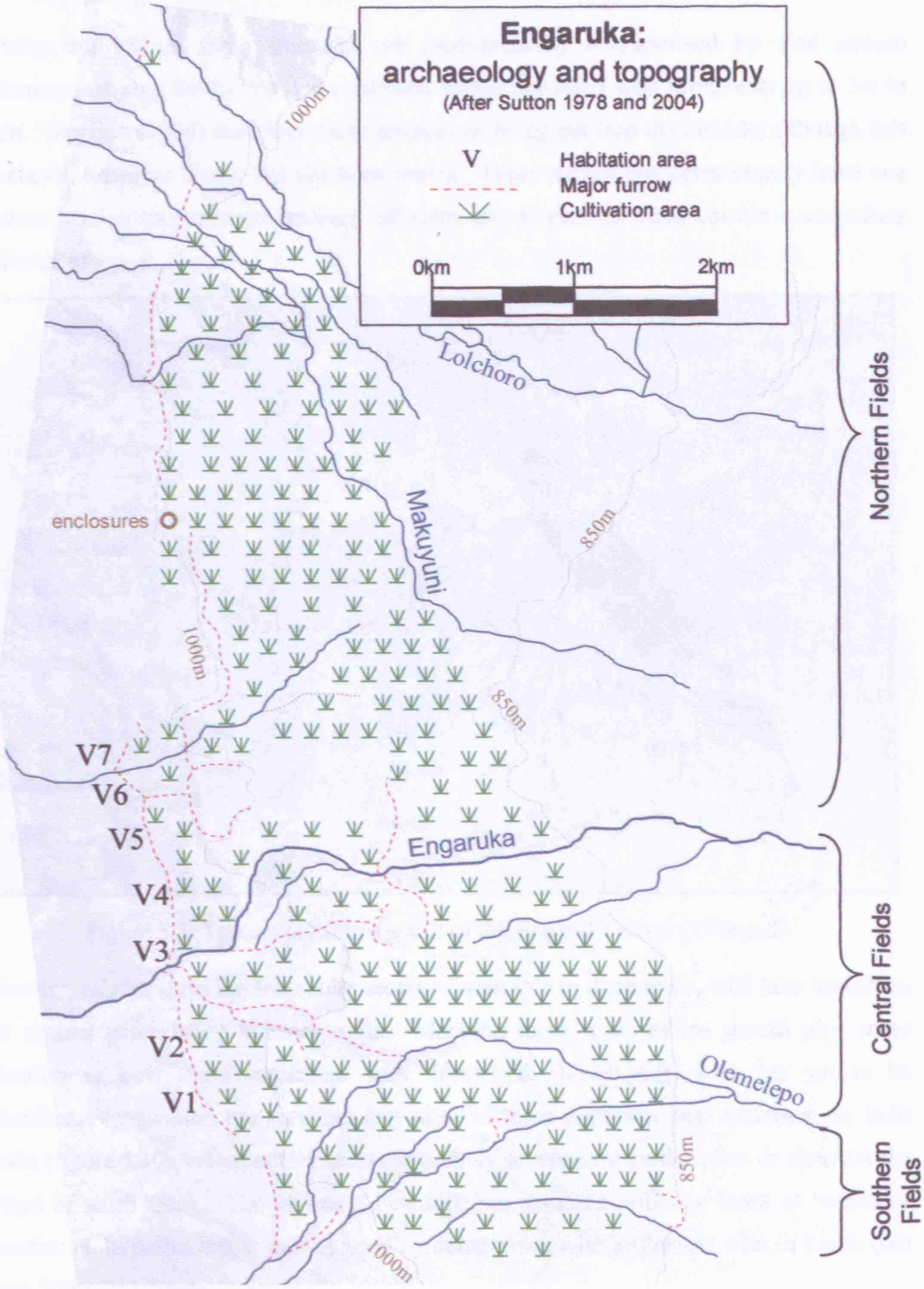

Figure 5.2: Archaeological and topographical map of Engaruka
Scale 1:50,000

(This map incorporates a satellite image of the site reproduced courtesy of Vesa Laulumaa)

The Hillside Structures

Within the village sites structures are predominantly characterised by oval terrace platforms averaging 8m by 5m and contained within dry-stone wall revetments up to 3m in height. Sassoon (1966) describes these terraces as being cut into the hillside, although this hypothesis, however likely, has not been tested. These terrace platforms usually have one entrance leading to pathways between adjacent structures, and often contain a secondary smaller platform.

Figure 5.3: Terrace platforms south of the Engaruka River (Village 2)

Abutting relationships are frequently clearly discernible in these areas, with later structures built against pre-existing buttress walls. Mapping these relationships should give some indication of how these settlement sites developed, though this work has yet to be undertaken. Excavation has revealed that some of these platforms also contain stone built hearths (figure 5.10), whilst others seem more likely to represent garden plots or areas for the stallage of small stock. The majority, however, are assumed to be the bases of houses or granaries; an hypothesis that is supported by comparison with settlement sites in Sonjo (see Sutton 2000: 218 figure 11.9).

The Central Fields

Archaeological remains within the central area to the immediate south of the Engaruka river are predominantly characterised by low stone-bounded terraces and fields (figure 5.4). For the main part these features seem to be constructed from single lines of stones, although in places two or three courses are visible. Sassoon (1966) notes that these areas are served by a series of stone lined 'paths' up to 1m in width, which Sutton (1978) later reinterpreted as irrigation furrows. These furrows can be traced to what Sutton terms 'main feeder furrows' which themselves link to a system of 'artery canals' that were fed from the natural watercourses, in this case the Engaruka River and the Olemelepo stream. Also within this area are considerable numbers of stone cairns (figure 5.5). These vary in design from simple piles to well-coursed walls around a rubble in-fill, some examples of which measure up to 2m in height. The construction methods employed in these larger examples are also used in the building of multiple stone circles (figure 5.9). Examinations of aerial (Sassoon 1966: 85) and satellite photographs (Laulumaa pers. comm.) indicate that there are approximately 50 of these structures, whilst walkover surveys demonstrate that these features are generally sub-circular in plan with diameters averaging 10m. Wall heights vary, but are generally over 1m, with a base width of roughly 2m. Initial interpretations saw these circular structures as house foundations though Sutton has since argued that they are more likely to represent stock enclosures (Sutton 1984).

Figure 5.4: stone-bounded fields, Central Fields

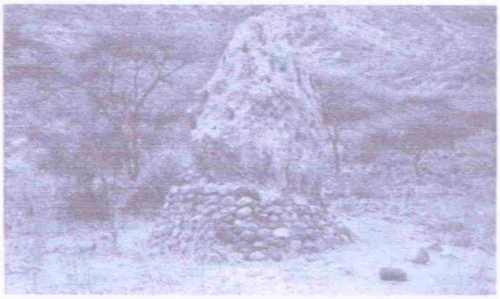

Figure 5.5: stone cairn, Central Fields

The North Fields

Of the artery canals identified by Sutton, the largest to the north of the Engaruka River runs along the base of the escarpment through a small valley formed by a hill to the east. As the canal passes through this valley a west to east aligned branch is constructed upon a natural ridge that appears to have been artificially heightened in places by the deposition of up to 3m of gravel (Sutton 2000 [1998]: 8-9). From here it is argued that the canal would have been able to transport water to the areas within the valley, and subsequently onto the area referred to by Sassoon as the northern field system. However, the description of this field system offered by Sassoon would appear to be merely the better preserved elements of a more extensive agricultural landscape subsequently identified by Sutton. The area described by Sassoon (1966: 85, and 82 figure 1a; 1967: 204) is nevertheless sizeable, covering approximately 200 hectares and characterised by a series of low terraces. Sassoon describes these as averaging 13m wide, measuring between 60m and 130m in length, and as being supported in places by dry-stone walls up to 30cm in height. Examination of aerial photographs suggested to Sassoon that this general pattern is repeated in groups of between six and twelve terraces, with the grouping based on differences in alignment. Colour variations seen from the air are interpreted as being the result of "better and deeper soil" (Sassoon 1967: 204) at the down-slope edge of the terraces. A series of walkover surveys conducted by Sutton demonstrate that the area of stone-bounded fields in this northern part of the site are more extensive than previously thought and extend at least as far as the Lolchoro River approximately 5km to the north of the Engaruka (see figure 5.2), with a further small area of fields recently identified beyond the Lolchoro suggesting that this area may be larger still (Sutton pers. comm. and site sketch in Sutton 2004: 115).

At a little more than 900ha this northern section thus represents over half of the former cultivation area identified to date. Moreover, excavation results reported upon here demonstrate that the differences in field alignment recognised by Sassoon are the result of a system of sediment capture and therefore reflect the line of natural watercourses that are later employed to feed irrigation features. Rather than simply representing agricultural plots sub-divided by single-course stone lines, the recent fieldwork also indicates that most if not all of these fields are contained within terrace walls.

Figure 5.6: North Fields looking west towards the Rift Escarpment
Note the now dry river gorge referred to by Sutton as the 'Intermediate North Gorge'

The South Fields

The complex of stone enclosures to the south of the Olemelepo are characterised by a series of stone lines organised into broadly rectangular plots which, when viewed from above, form a large grid pattern (figure 5.7) described by Sassoon (1966: 85) as appearing "not far removed from haphazard". The plots average 4m by 5m but frequently measure up to 6m by 8m, and are associated with double lines of stones interpreted as paths by Sassoon, but later viewed as irrigation furrows by Sutton (1978). As with the areas described above, Sutton's re-examination of this part of the site has also led to the identification of several major irrigation features (see figure 5.2), whilst walkover and satellite image interpretation carried out during the current project suggest that the method of construction is similar to that proposed here for the North Fields area. Consequently, much of the southern section of the site should also be viewed as comprising low terraces rather than simply single-coursed stone lines. The total area covered by this field system is approximately 350ha.

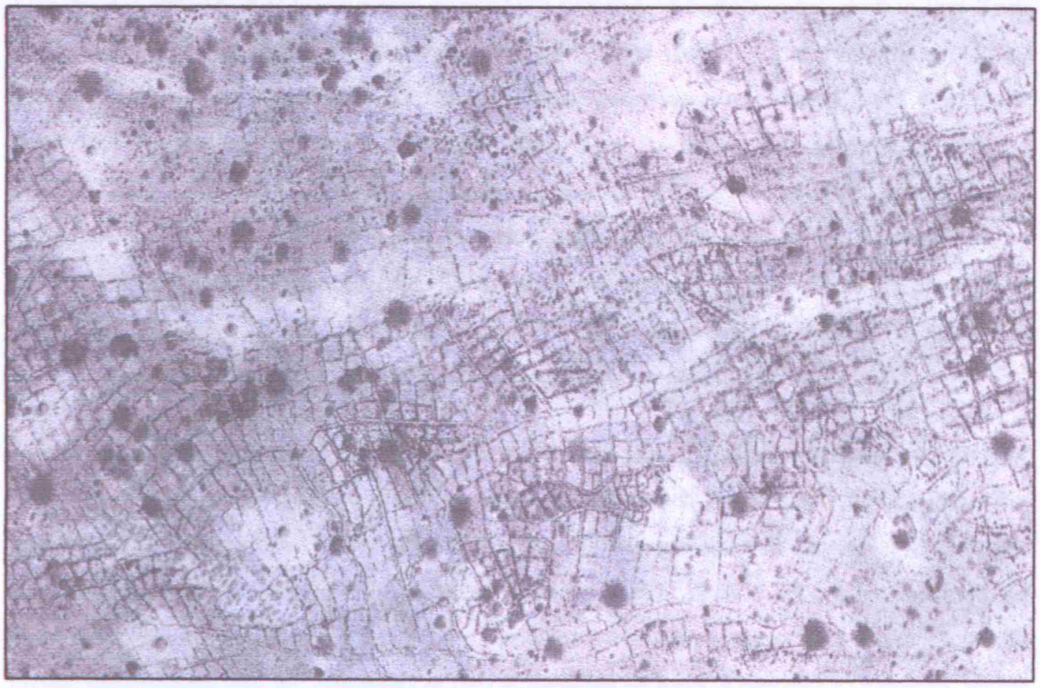

Figure 5.7: Detail from an aerial photograph of the South Fields taken in 1964 (courtesy of Tanzania Survey)

Research Context

1883 - 1935

Although the existence of extensive abandoned stone-built structures at Engaruka was referenced as early as 1883, the site has received relatively little direct archaeological attention. Sassoon, who carried out excavations at the site in 1964 and 1966, notes visits by Fischer (1883, cited in Sassoon 1966 and 1967), Schoeller (1901, cited by Sassoon 1966) and by Jaeger and Uhlig (visited 1904, account published by Jaeger 1913, cited by Sassoon 1966). However, the published accounts offered by these three authors are essentially impressionistic descriptions of the ruins, combined with informal interviews with local inhabitants regarding the ethnicity of the site's original population. Jaeger, for example, notes that the stone structures were locally attributed to the Tatoga (Datooga).

It was not until 1913 that the first methodical intrusive investigations where carried out, when Reck spent a day excavating three cairns (Sassoon 1966 and 1967, citing Reck 1926). The assumption was that these cairns marked the position of burials; a proposition that Reck thought to have confirmed by the discovery of skeletal material that was interpreted as consisting primarily of human long bones. These bones were recovered from within the matrix of the cairn's rubble in-fill rather than from an underlying grave cut, and are described as being disarticulated, fragmentary, and deposited in association with faunal remains. In reviewing Reck's report, Sassoon makes no reference to the whereabouts or even to the continued existence of the site archive and, as such, it is not presently possible to confirm the validity of the original interpretation. In addition to the organic finds, Reck's work recovered linear decorated ceramic fragments from one of the cairns.

Given the limited scope of the fieldwork, there was clearly insufficient data generated for the project to phase or date the site's occupation. However, on the basis of the generally good state of preservation it was argued that the site should be seen as a relatively recent construction. An ethnographically based section within Reck's report by Ankermann concluded that the cairns at least could be considered to be the work of an Hamitic nomadic group; conclusions that are reiterated in two summaries of Reck's Engaruka fieldwork which are included in more general discussions on the archaeology of the region (Reck 1933 and 1935, both cited in Sassoon 1966). These later overviews appear to have inspired a visit by Wetheral, who published accounts of his impressions in both *The Tanganyika Standard* (10th July 1935) and *The East African Standard* (11th of October 1935, both cited by Sassoon 1966). Shortly after the publication of the first of these reports L.S.B. Leakey conducted a three week field season whilst on route to Olduvai Gorge.

1935 – 1958

Leakey's project consisted of a walkover survey, interviews with local Maasai Elders, and trial excavations on both the hillside and the valley floor. From the walkover Leakey estimated that there were in the region of 6,300 houses located on the lower escarpment slopes, with a further 500 round-houses situated in the valley. However, his population estimate of between 30,000 and 40,000 is partially based on the misidentification of the central area fields as building foundations. Through interviews he was informed that the Maasai believed the site to have been occupied by the Wambulu (Iraqw) prior to their forced removal by the Maasai between 100 and 150 years earlier. Coupling this proto-historical data with preservation considerations led Leakey to place abandonment at between 300 and 150 years ago (Leakey 1936).

The excavation methodology employed by the project included, in Leakey's terms, the investigation of one large and one small 'burial cairn'; the excavation of a large 'house' from the valley ruins, and the insertion of a further trench into a small house from the hillside cluster (ibid.). The two cairns produced no human skeletal material, though pottery sherd finds were recorded. This did not lead Leakey to radically revise his initial interpretation however, as he concluded that the local soil chemistry was not conducive to the preservation of bones. Similarly, the discovery of a sunken stone hearth at the base of the excavated terrace platform on the lower hillside slopes also confirmed to Leakey's satisfaction his pre-excavation hypothesis that the structures represented the remains of permanent houses. Overlying contexts yielded an artefactual assemblage that included beads, pottery sherds, faunal remains and a small iron 'razor'. The finds collection from the circular stone structure located within the central area of fields was similar to that recovered from the hillside building.

Two years after the publication of Leakey's preliminary report, Fosbrooke produced a follow-up discussion that employed ethnographic analogies to argue that Sonjo, located approximately 60km to the north-east, should be seen as the successor community. The article also contains a photograph of Leakey's hillside structure excavation which shows the sunken hearth surrounded by horizontally-set flat stones (see figure 5.10), giving the feature the appearance of a fireplace within a communal seating area (Fosbrooke 1938). A later Fosbrooke article published following the 3rd Pan-African Congress on Prehistory introduced a line of enquiry that has received considerably more interest recently and which remains a priority for current research (Westerberg 2001 and 2002). By combining population estimates with a rudimentary hydrological survey, Fosbrooke raises the question of whether the abandonment of the system could be seen as evidence of desiccation, climate change, or diminishing river levels (Fosbrooke 1957).

Sassoon's 1966 discussion of the previous work at Engaruka, upon which the current summary is partially based, also makes reference to the discovery of a stone built dam constructed to a height of 2.5 metres and located at the northern end of the site (Chittick 1958 cited in ibid.). This feature has subsequently been reinterpreted by Sutton, and is described above as the artificially banked section of the 'great northern canal' (Sutton 2000 [1998]: 8 and figure 5). Further to reporting this recent find, Chittick discusses the nature of the settlement, arguing as Leakey had previously, that the choice of the hillside location was motivated by a perceived need for defence.

The 1964 excavation

Following Leakey's excavation there was a gap of 29 years before further concerted intrusive archaeological research was carried out on the site. The fieldwork that ended this hiatus was directed by Sassoon (then the head of the Tanzanian Department of Antiquities and charged with documenting Tanzanian heritage) and comprised two seasons of investigation in 1964 and 1966. The first season was intended as a preliminary programme and was thus on a similar scale, and employed a similar methodology, to that undertaken by Leakey. This included the excavation of four cairns, a stone circle within the central valley field system, and four trenches through terrace platforms on the lower escarpment slopes (Sassoon 1966).

The four excavated cairns were all situated to the north-west of the modern village of Engaruka and to the south of the Engaruka River in an area characterised by small rectilinear field divisions and furrows. The first two of these cairns were designated as B1 and B2, and were located immediately adjacent to a stone circle that was also trenched during that season (contexted as C1, see below). Both are described as being less than one metre high, but no indication of circumference is offered by the 1966 report. Similarly, Sassoon does not mention whether these cairns are neatly faced around a rubble in-fill as is common on features of this sort at the site. Unfortunately, at present the original excavation archive has not been reviewed and, as such, it is not possible to clarify some of the ambiguities from Sassoon's report. For example, Sassoon (1966: 92) mentions that "[B1] was excavated to a depth of 70cm below the land surface" in an attempt to test the burial feature/marker hypothesis. However, it is by no means clear whether this excavation was following an underlying grave cut or, indeed, whether this 70cm limit of excavation was prompted by a change in the depositional sequence. Nevertheless, it is noted that a limited quantity of pottery sherds and some charcoal fragments were recovered from within the cairn matrix, implying that the underlying soil was artefactually sterile. The pottery was designated as belonging to variants 1 and 3[7] of an eight type, site specific typology; forms that were also recovered from the stone circle C1. Cairn B2 similarly produced pottery forms that Sassoon considered to be closely related to types recovered from C1 contexts[8].

The two other excavated cairns are located approximately 600m to the south of C1, and are described as "low mounds of stones, hardly justifying the term cairn" (Sassoon 1966: 94). The first of these, contexted as B3, was excavated to a depth of 2m but produced no artefactual data. B4, in contrast, was excavated to 0.9m where a crouched burial was uncovered. The skeleton is recorded as being in a fragmentary state but was sufficiently well preserved to discern the burial position: placed on its right side, facing north-west, with the hands positioned in front of the face.

Stone circle C1 is situated roughly 200m to the south of the Engaruka River within the Central Fields at approximately 35°57'24" E, 2°59'55" S. The structure is recorded as being 9m in diameter and as averaging 1.5m in height, with a mean wall width of 2m at the base. A narrow opening approximately 1m wide is located facing the north-west. Sassoon's methodology employed an initial 0.6m x 0.4m trial-pit positioned within the entranceway, coupled with the excavation of 2m x 2m square sub-divisions of the feature's internal area. These were all excavated in three arbitrary 15cm spits, at which point both the base of the wall and a possible rough cobble floor were encountered. The lowermost 'layer' overlying the floor was interpreted as the building's occupation horizon and contained a "marked concentration of bone and potsherds" (Sassoon 1966: 86). Working on Leakey's assumption that the stone circles represented the remains of roofed habitation structures, Sassoon made a concerted but unsuccessful effort to locate internal postholes.

Although it should be reiterated that the original excavation observations and drawings were not reviewed for this summary, it is noteworthy that the published report offers a

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[7] The first of these is described as a dense, inclusionless grey-ware with an oxidised internal face, and neat horizontal incised banding applied to the outside. The second is a coarser fabric with occasional mica and quartz inclusions, and a dark reddish brown outer face. Decoration of type three consists of inverted triangles shaded with horizontally incised lines, and with one or more deeply impressed lines of pin-pricks skirting the rim (Sassoon 1966: 86, illustrated 87, figure 3)

[8] These were types 2, 3 and 4. Type 2 is similar in terms of fabric and decoration to type 1, though here bands of vertical stripes are included below the horizontal linear decoration. Moreover, Sassoon describes this form as being thinner and lighter than type 1, and to be oxidised on both the inner and outer faces, with the resultant reddish colouration extending more than 1mm into the core when viewed in section. Type 4 is characterised as another partially oxidised coarse grey-ware with frequent quartz and occasional mica inclusions. The external decoration comprises roughly applied linear bands (ibid.).

confusing account of the stone circle's internal stratigraphy. Sassoon notes the prevalence of cross-context conjoining pottery sherds, which he takes as evidence that the depositional sequence had been disturbed post-abandonment, either by 'treasure-hunters' or through the later use of the structure as a cattle pen. This post-depositional disturbance hypothesis seems unnecessary however, because Sassoon's 'layers' are elsewhere explicitly described as arbitrary in both depth and plan; a confusion that appears to have been exacerbated by the use of a unit rather than episode-based recording methodology. It would seem more probable from the published description, therefore, that the upper central deposit was homogenous to a depth of 45cm. This is in keeping with a stock stallage interpretation for the structure as preferred by Sutton (for example Sutton 1986), since the dispersal of finds can be accounted for as being secondary discard material, re-deposited along with organic refuse used as fodder. Such an interpretation would also explain the abraded condition of the recovered ceramic material. In the subsequent conclusion of the 1966 article, Sassoon comes close to this interpretation himself, but opts finally for a view that sees the stone circles as human dwellings.

In addition to the ceramic finds, the combined C1 contexts also produced 43kg of largely fragmentary bovine bone; 58 ostrich shell beads and 48 snail shell beads; three cowries and two imported glass beads. Furthermore, over twenty iron objects including arrow heads, awls and three rings, as well as four pieces of chipped obsidian and 11 roughly worked chert fragments were recorded. An attempt was also made to begin to construct an absolute chronology by carbon-dating four charcoal samples recovered from the layer that sealed the cobble 'floor' within C1. These four fragments were combined and run as a single sample (GX-247); producing a result of 490±90 years BP. This result was later calibrated to one standard deviation by Robertshaw (1986: 18) using the AD calibration curve presented by Stuiver (1982), and has been recalibrated for the purposes of this discussion using Stuiver et al. (1998) and the southern hemisphere curve presented by McCormac et al. (2004). The calibration results are presented in figure 5.11, and suggest a fourteenth- to early seventeenth-century date.

The final group of features examined during the 1964 season were all within the 'village' site to the immediate north of the Engaruka River gorge (designated 'hillside 3' by Sassoon and marked as V3 on figure 5.2 above). In all, four terrace platforms were investigated, and were assigned the group contexts A1 to A4. A1 was excavated to 15cm below current ground level and produced just six pottery sherds, to which Sassoon assigned the typological designation type 6[9]. A3, was investigated via two 2m² evaluation pits, one of which was excavated to a depth of 30cm, the other to 60cm. Limited quantities of artefactual data were recovered and no negative or positive features encountered. Hillside structure A2 was also excavated to a depth of 30cm. Sassoon offers no structural information from this terrace in the published 1966 report, limiting his observations to a list of the retrieved artefactual material. This material archive includes a good proportion of a single vessel described as type 5[10]; a blue drawn-glass bead; two snail shell pendants; iron objects including awls, a blade and a chain, as well as fragments of rubbing stones and querns. A4 was only partially excavated due to lack of time, but is nevertheless described as producing a greater concentration of pottery than the previous three structures. These were assigned the typological characterisations 6, 7[11], and 8[12], and were uncovered in association with a small quantity of animal bone, as well as ornaments including beads and fragments of an ivory bracelet.

Two charcoal samples from A2 were submitted for radiometric testing and produced results of 1620 ± 90 BP for the lower level (GX-348) and 1230 ± 120 BP for the upper level (GX-347); results that can be calibrated to the early third to early seventh centuries, and to the early seventh to mid-eleventh century respectively (Stuiver et al. 1998). Employing the southern hemisphere curve produced by McCormac et al. (2004) generates very slightly later date ranges for both samples, though the relative probability within the range for GX-348 suggests a date between 320 and 650 cal AD. Sassoon (1966: 92) comments that these dates are earlier than anticipated and argues reasonably that they would require further corroboration if they are to be accepted. This concern is reiterated the following year (Sassoon 1967: 216), however, the results are nevertheless employed to argue that the earliest occupation of the hillside structures pre-dates the construction of the stone circles in the Central Fields area.

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[9] A Type 6 vessel was sufficiently reconstructed to suggest that it was a small globular pot. The fabric is dark grey with deep reddish colouration on both the exterior and interior faces of some of the recovered examples. Mica inclusions are common, quartz occasional, as are small (<4mm) fragments of white clay, interpreted by Sassoon as probably derived from decayed felspar. Decoration consists of two 4cm deep bands of irregular horizontal stripes (Sassoon 1966: 92, illustrated 93 figure 9).

[10] This is described as a large globular pot with a black friable fabric containing abundant quartz inclusions. The surface treatment is smooth, with four panels of 11 horizontal lines made by impressing a stylus (Sassoon 1966: 91, figure 8).

[11] Similar to type 6 but with a brick red colouration. Decoration is also very similar, here consisting of one or more 2-3cm thick bands of horizontal stripes. The two forms are therefore clearly very closely related and could be viewed as individual examples of the same form (Sassoon 1966: 92, illustrated 93 figure 9).

[12] Type 8 consisted of a single recovered vessel made from a quartz-rich, friable red fabric. Sassoon notes that a fine black band can be seen in the centre of the core in places which might indicate that the vessel was poorly fired. The pot surface is coarse, and the rim and neck have been decorated with a small knotted roulette, probably made from grass (ibid.).

Shortly following the 1964 excavation the area was photographed from the air by the Air Survey Division of the Tanzanian Government's Ministry of Lands, Settlement and Water Development (Sassoon 1967). Given that the level of vegetation cover in the immediate environs of the site was lighter at the time of the survey than at present (Sutton 2000 [1998]: 12-13), the images produced by the 1964 reconnaissance still offer the best template for desk-based mapping of the archaeological features.

The 1966 excavation

One of the principal aims of the 1964 excavation was to identify areas that could be targeted for further fieldwork in order to answer general research questions relating to chronology and site function. The areas most obviously in need of further work as identified by the first season, owing both to the relative density of finds recovered from these contexts and as a response to the limited structural data uncovered in 1964, were the hillside settlement locations. As a result, the 1966 excavation examined 17 terrace platforms and 12 small structural features that Sassoon describes as 'small hillside enclosures' (Sassoon 1967), with the intention of establishing a ceramic-based relative chronology. Once again, at the time of writing it has not been possible to locate and review the original excavation archive, and, in consequence, the current summary is based on an overview presented in Sassoon's 1967 article.

Unfortunately, this article's discursive style raises several stratigraphic and taphonomic questions that cannot be resolved without examining the original site drawings or photographs. For example, the largest and most extensively excavated terrace platform, A5, is described as including "dry stone walls at various levels within the occupation deposit" (Sassoon 1967: 205); an observation that strongly suggests multiple phases of use within this structure, though without additional detail it is not possible to draw any definitive conclusions as to what these uses may be, or whether this data represents evidence of abandonment and re-occupation. However, Sassoon's description of this terrace's containing walls and of a burial uncovered at its base appear to present good evidence of settlement expansion. Sassoon reports with surprise that the outer (i.e. down-slope) containing wall abuts 2m of internal occupation deposits and is therefore interpreted as being a later element designed to revet these layers, whilst the same platform's inner wall did not extend to the base of the internal occupation layers, but instead, has its foundation just below the current ground level. The burial of an adult in an upright crouched position is described as being:

> within the buttress wall in A5, and at its base [...]. The top of the skull was about 2m below present ground level, and the burial had been marked with a

> ring of large stones placed around and slightly above the skull. The ring of stones probably indicates ground level at the time of burial.
>
> (Sassoon 1967: 205-6).

Taking the A5 terrace walls and burial evidence together, it would seem likely that, at this point at least, the settlement is expanding downhill, over burial and possible discard material that had previously been deposited outside the occupational areas. Indeed such an interpretation would fit with observations made during the present project that terraces are built by employing the outer edge of a pre-existing structure as the inner wall for new platforms. If Sassoon is correct in interpreting the ring of stones associated with the burial as an indication of the level at which the grave was cut, the only alternative is to see the burials as a form of foundation deposit, but if this were the case one might expect all inhumations to be associated with construction episodes. In fact, of the four burials uncovered by Sassoon, only one closely mirrors the A5 skeleton, being of a further upright crouched burial below the rear revetting wall of another terrace, whereas the remaining two were both found at the centre of terrace platforms. Of these, one was a upright crouched adult, the other a child positioned on its left side.

By excavating a large number of terrace platforms from the settlement sites and, where possible, taking these down to the base of the anthropogenic deposits, Sassoon was able to demonstrate that the different structures performed differing functions. Several, for example, contained very little occupational debris and the soil matrix appeared to have been deliberately cleared of stones, suggesting that these functioned as small garden plots. Conversely, a small oval enclosure was excavated that contained, at a depth of approximately 10cm, an example of the sunken hearths previously described by Leakey and Frosbrooke (see figure 5.10). A further structure produced iron fragments and slag in association with large stones that Sassoon identified as possible anvils, leading him to interpret the structure as a possible forge or workshop (Sassoon 1967: 206). A discussion section to the 1967 report mentions that soil samples retrieved from hillside contexts were in the process of being analysed in the hope that these might help discern which terraces were occupied, and which were previously employed as agricultural platforms. The intention was to examine the concentrations of nitrates and phosphates within these samples (Sassoon 1967: 209), however, the results of these tests, if they were obtained, are not discussed in Sassoon's later account of the fieldwork (1971).

The finds assemblage produced by the 1966 season was predominantly similar in kind to that recorded in 1964. However, in addition, several small vesicular lava bowls were recovered from various contexts, and were interpreted as smoking pipes. In terms of economic reconstruction, the recovery of arrow heads, (?)sling shots, quern fragments and small quantities of carbonised sorghum, point towards a mixed subsistence strategy, though the relative importance of each is clearly impossible to discern from the finds alone.

Post-excavation analysis from the 1966 season included a further attempt at carbon dating, although at the time of the 1967 report the only additional results available were from two bone samples from A5 contexts. An animal bone recovered at 1.65m below current ground level produced a date of less than 70 BP (GX-742), whilst a sample taken from the A5 human skeleton produced a determination of 160 BP (GX-743). Sassoon largely rejects these dates however, on the grounds that the rate of deposition required was thought to be too rapid, and because the suggested date range would coincide with the first European travellers to have visited the site. In a later discussion of the Engaruka radiocarbon determinations, Robertshaw (1986: 17-18) also excludes these two results on the grounds of known problems with bone as a sample material. In addition, Robertshaw discusses the radiocarbon results from six further samples collected by Sassoon in 1966 (Sassoon 1971). Of these, five (GX-900, UCLA-1615a, UCLA-1615c, M-1892 and M-1893) are from 'Hillside 2' (i.e. from the group of terraces to the south of the Engaruka River), whilst a single sample (M-1894) is from an oval enclosure from 'Hillside 1' (the southernmost group of habitation terraces). Calibration of these results suggests a period of occupation spanning the fifteenth to eighteenth centuries, although at 95% confidence M-1892 may be as early as the late thirteenth century (Stuiver and Kra 1986, Stuiver et al. 1998 and McCormac et al. 2004 – see figure 5.11).

1964 and 1966: synthesis and excavator's conclusions

Based on the two seasons fieldwork, Sassoon draws a number of conclusions and suggests areas that require further work. In terms of dating, Sassoon (1967 and 1971) principally defers to the available radiocarbon results, arguing that the stone circles date to around the fifteenth century, and that the recovery of similar pottery types from the excavated cairns suggests that these two feature types are contemporaneous. The field system within the central area is seen as the agricultural base for the population that occupied these circles. Combining the radiocarbon data with evidence for what appears to be an overlapping of the pottery traditions recovered from the hillside and valley locations, Sassoon argues for a long occupation of the hillside terraces. Despite expressed reservations regarding the early radiocarbon dates from terrace A2 (GX-347 and GX-348), it is argued that the small sample set suggests no reason why these should be completely rejected and, as such, a first millennium AD date is proposed for the hillside terraces, although it is noted that some structures in this area are likely to be considerably later (Sassoon 1967: 210 and 216; 1971). However, by employing the hillside stratigraphic data discussed above, it is further argued that "it is possible that the lowest levels excavated belong to a period which is BC rather than AD" (1967: 210). The hillside terraces and the ruins within the Central Fields are, therefore, viewed as being the material remains of two distinct cultures, with the latter appearing towards the end of the period of hillside occupation. Both cultures' economies are seen as being based on the rain-fed cultivation of sorghum; a conclusion that leads Sassoon towards a theory of abandonment based on environmental deterioration (ibid.: 216).

In contrast to the earlier population estimates that saw site demography in terms of tens of thousands, Sassoon suggests that the maximum number of inhabitants was unlikely to have exceeded 4000 at any one time. An interpretation of the cairns as burial markers is also rejected in favour of field clearance features, grain store bases, or possibly even as raised beds for the cultivation of other plants. Moreover, the presence of glass beads and cowries are seen as demonstrating some level of external trading, though it is noted that this could take the form of down-the-line, rather than expeditionary exchange, and need not require a conscious involvement in a broader trade economy. Similarly, limited evidence of on-site smelting and a failure to identify a local clay source are employed to suggest that even the pottery and metalwork are imported. The picture presented is, therefore, one of an area with a recognisable natural resource base which encouraged its occupation and exploitation by at least two distinct groups over a period of not less than 1000 years. This habitation required systemic modification of the local environment and the importation of several commodities, but was nevertheless sufficient to support a population higher than that sustained at present. Falling precipitation levels gradually rendered this subsistence strategy untenable, prompting abandonment of the system in the mid- to late second millennium AD.

The 1971-2 survey

An extended programme of walkover survey at Engaruka was carried out by J.E.G. Sutton between 1971-2, the results from which were reported upon in 1978. This is not, however, the first time that Sutton had considered the significance of the site in print, as an earlier article referenced Engaruka as a counterpoint in an anti-diffusionist argument that refuted the existence of a widespread east African ancient civilisation to which all terrace sites could be attributed (Sutton 1969). In this 1969 paper, several late eighteenth- and early nineteenth-century accounts of terrace agriculture are dismissed as misidentification, whilst others, such as Tambach in Elgeyo, are interpreted as relatively modern developments. Significantly from the point of view of his later work, Sutton (1969: 3) considers that "most, if not all" of the terraces at Engaruka were irrigated. This observation is reiterated in Sutton's 1978 report, where it is substantiated by reference to on-site survey results.

The model of irrigation suggested by the 1971-2 survey is summarised above in the 'archaeological site description' section and is illustrated in figure 5.2. The methodology employed in mapping this system involved identifying the main artery canals where they run along the escarpment base (of which the first to be located was the comparatively well preserved example that leads south from the Makuyuni), and attempting to link these to the irrigation furrows evident within the field systems themselves. In places, the lines of these irrigation features had to be extrapolated across areas where post-abandonment erosion had either buried or disturbed the original features. It is stressed, therefore, that the survey results should not be seen as an exact model of irrigation but are presented instead as a reasonable characterisation of the techniques and structures employed. Having encountered no areas in which the layout of the fields or furrows appeared to have been modified through time, the survey was not able to identify distinct stages of development (Sutton 1978: 45), although it was noted that the perennial Engaruka River was likely to have been the first water source to be exploited. Indeed, Sutton notes that there is considerable overlap between the areas that could be watered by the canals fed by the Engaruka and those based on the Makuyuni and Olemelepo streams, prompting him to argue that these latter water sources were only seasonal supplies, even during the period of occupation.

Although the irrigation system and related fields are not stratigraphically placed within definable phases of development, Sutton (1978: 58) stresses that the stone circles and cairns are superimposed over earlier agricultural features. This prompts Sutton to argue that these features share a defensive function, with the circles as defendable cattle corrals, and the cairns as look-out posts. Sections of the terraced wall towards the extreme south of the system are similarly interpreted as probable late additions designed to defend water sources. Indeed the settlement sites themselves are seen as defensive, though the need to retain all irrigable land for agricultural production is seen as of equal concern. It is not suggested, however, that some of the sizeable terraces that frequently mark the easternmost limit of the settlement areas date to the same period as the cairns and circles. Given the suggested chronology, it is speculated that the arrival of the Maasai in the region may be the cause of the perceived threat, if not the actual stimulus of desertion. The arrival of an aggressive group within the area (whether Maasai or otherwise) is not considered to be the sole reason for abandonment, however. In contrast, the superimposition of later features over elements of the area of cultivation is thought to represent evidence that the economy was in decline:

> But it is unlikely that this [the construction of the later features] indicates a complete abandonment of the irrigation system or cessation of agriculture at Engaruka, or that the cairns and enclosures represent the arrival of a new group of people, or a separate period of occupation. Rather I suspect that these features belong to a late phase of a single, though extended, occupation by an

essentially continuous population, this late phase being a time when increased security [...] or a diminished water-supply, as well as the effects of soil erosion and infertility, or more probably a combination of these factors, threatened the viability of the community and forced it to abandon or modify a proportion of the fields.

(Sutton 1978: 47).

Although several of these lines of enquiry regarding causes of abandonment are somewhat speculative, they remain credible and pertinent, and for the main part are hypotheses that still require testing. Of these, the question of declining hydrology is the theory most favoured in Sutton's later work (for which see below), though whether this diminishing of flow was caused by falling precipitation levels on the Crater Highlands, deforestation of the river catchments, or disruption of the watercourses, remains uncertain. Nevertheless, the opinion expressed in the 1978 article is that the current water levels in the three main rivers are well below those capable of feeding the estimated 2000ha of stone demarcated fields, and indeed are physically lower than the material remains of the off-take canals that were presumably built to divert water without the need to lift it manually to the canal heads. Moreover, Sutton highlights that in several areas of the site fields are constructed on land that lies above the level that can be irrigated by gravity fed canals based on either the currently perennial or seasonal streams, suggesting that these were watered from what are now permanently dry stream beds.

In questioning why members of the community were prepared to terrace, revet and water areas such as these for arable production, Sutton highlights an issue that has become something of a recurrent theme within the discourse on intensive agriculture in the anthropological, geographical and archaeological literature: did pressure on land force the expansion of the agricultural system to exploit all potentially cultivated land, and if so, what was the cause of this stress. Although Sutton does not formally cite the related population pressure based models of Malthus (1985 [1798]) or Boserup (1965), it is argued that limited available resources may have led to over-exploitation and thus eventual soil exhaustion or excessive salinisation (Sutton 1978: 59). Here again it seems to be assumed that at some point all available land was under cultivation, though it is acknowledged that systems of fallowing and/or maintenance of soil fertility through manuring would probably have been employed in an attempt to alleviate these effects.

Combining perceived evidence of external competition (defensive structures) with possible indices of over-specialisation (the apparent exploitation of all available land) and marginality (the relative paucity of imported material within the recovered artefactual assemblage), Sutton conjectures that the operating community may have had something of an insular aspect to its group identity which acted to make it both geographically and culturally isolated. Such an outlook might have limited the community's options when reacting to problems arising from agricultural failures, and reduced their ability to call on alternative resource exploitation strategies. Arguments along these lines are refined in Sutton's later work, and will thus be discussed further below.

The consideration of the extant society at Sonjo as a possible successor community to Engaruka is again a debate that is refined in Sutton's subsequent writings. However, the case made in the 1978 article raises the issues discussed in more detail later: the apparent similarities in house styles and agricultural techniques at Sonjo and Engaruka are contrasted with differences in pottery styles, irrigation structures and methods. Interview evidence demonstrating that the Sonjo have no connection with Engaruka in their oral tradition is also noted, though this too requires some modification in the light of later work (Nurse and Rottland 1993). Nevertheless, Sutton tentatively posits that members of the Engaruka community may have been subsumed into the Sonjo society, reapplying elements of their agricultural system in this new location. This approach to locating possible cultural connections with the abandoned site acknowledges that the desertion of Engaruka need not have taken the form of a catastrophic collapse.

That Engaruka may have had some localised cultural connections is also addressed through the description of other sites comprising what Sutton terms the Engaruka Complex. These sites all occupy similar topographical situations to Engaruka and all exploit perennial streams, though only the site of Oldogom includes structures that might represent a nucleated village of the Engaruka type. Possible furrows, cairns and field walls have been identified at Mtu wa Mbu and at Olpira, Endamaga and Oldogom near Lake Eyasi. The abandonment of these sites and the probable late date of the desertion of Engaruka make it extremely unlikely that these are successor communities, but it remains possible that these features are the result of out-migration from the apparently more densely populated Engaruka. More work, particularly as regards the establishment of a detailed chronology, would clearly be necessary to discern how the other Complex sites relate to each other.

In summary, Sutton's 1978 article describes both Engaruka and other similar sites of what is termed the 'Engaruka Complex', and questions several of Sassoon's conclusions as outlined above. The most fundamental revisions suggested are the assertion that the system should be seen as irrigated agriculture; the rejection of the argument that the hillside and valley ruins should be regarded as the products of two distinct cultural groups, and the questioning of Sassoon's long chronology. Sutton argues, therefore, that:

> All the visible diverse archaeological remains at Engaruka should belong to one period, but a period containing at least two main phases probably spanning altogether a few centuries. The features added during the later phase appear designed to protect and bolster as much as possible of the established agricultural economy in a deteriorating situation.
>
> (1978: 48).

Excavations carried out by Robertshaw in 1982 were designed to help ascertain which of these divergent conclusions best fitted the retrievable archaeological data, or indeed, whether an alternative interpretation would present itself.

The 1982 excavations

The methodology employed in 1982 was to combine an examination of two stone circles from the central area, with the investigation of two terrace platforms and two small enclosures from the hillside 'village' adjacent to the Engaruka River (Sassoon's 'Hillside 3'). These structures were designated the group contexts A-F respectively (Robertshaw 1986). Although it should be borne in mind that the fieldwork was hampered by bad weather, in many ways the excavation techniques employed rendered the project more limited in scope than Sassoon's combined seasons. For example, stone circles A and B were trenched, rather than completely excavated, and indeed in A, only the easternmost 2m x 2m segment of the original 9m x 2m trench was fully examined. The upper 0.9m of the depositional sequence within A produced three undecorated pottery sherds, a single glass bead and fragments of bone, whilst the remaining 0.25m consisted of medium to large stones within a whitish volcanic ash matrix and contained no artefactual material. It is suggested that the encountered stones might represent the remains of an earlier collapsed cairn or a field wall (Robertshaw 1986: 2). The depositional sequence revealed by the excavation within stone circle B was of the same form, though shallower than, that seen in A. The upper deposit contained a few undecorated pottery sherds, and sealed 0.1m of soft volcanic ash that was again found to be artefactually sterile.

Of the investigated features from the hillside area, platform C was by far the largest at approximately 24m by 8m. This was examined via four 2m x 2m trial pits, none of which were positioned to encounter the retaining walls and, as such, cannot be employed as a means to solving some of the stratigraphic uncertainties discussed above in reference to Sassoon's second season. Equally the four test pits were not excavated to the base of the anthropogenic deposits: pits C1 and C2 were halted at a depth of 0.3m; C4 at 0.45m and C3 at 1.8m, though here an exploratory sondage was sunk at the base of the pit which demonstrated the continuance of the depositional sequence for at least a further 0.2m. It is noted that "no specific evidence of a house or other structure was found on this terrace"

(Robertshaw 1986: 4), but neither would this be expected via a methodology that did not seek to examine the base of the feature or the relationship between the excavated material and the terrace's containing walls. Robertshaw took the presence of similar pottery forms recovered from throughout the sequence as evidence against a long occupation, yet also argues that "it seems clear that there is considerable mixing of deposits, presumably resulting from repeated rebuilding of terraces" (ibid.). A radiocarbon date (Har-5477) extracted from charcoal fragments collected between the depths of 1.65 and 1.8m produced a figure of 220±80 BP which Robertshaw calibrated using the curve presented by Stuiver (1982) to produce a date of 1520-1810 cal AD. Recalibration of this determination presented here in figure 5.11 suggests that the sample is more likely to date to the early seventeenth century or later (Stuiver et al. 1998 and McCormac et al. 2004).

The remaining three features examined in 1982 were similarly not excavated to base level. However, these smaller features were effectively half-sectioned. Terrace platform D, located to the immediate east of C, was excavated to 0.3m below the modern ground surface, and was interpreted as a probable house platform. E, a small enclosure south-southwest of C, was also half-sectioned to a similar depth, revealing the familiar structure of a stone built paved area as described previously by Leakey, Fosbrooke, and Sassoon. The fireplace that these earlier excavations suggest is normally within such features was not excavated, however, charcoal fragments from just below the paved area were submitted for radiometric testing (Har-5476), producing a result of 280±90 BP; a date which can be calibrated to the mid- to late fifteenth century or later (Stuiver et al 1998 and McCormac et al 2004). The deposit that overlaid the floor area contained a considerable quantity of pottery and bone and was thus interpreted as a domestic refuse dump, suggesting that the feature was abandoned whilst nearby structures continued to be occupied. A carbon sample (Har-5475) from within this material produced a figure of 190±80 BP; a result that calibrates to the same period as the sample from terrace C. Problems of lack of time and poor weather precluded an attempt to fully examine a further terrace, F, located approximately 15m to the west of E. The investigation of this feature was therefore restricted to a preliminary clearance of the uppermost 0.15m within a 2m wide trench which, nevertheless, produced a considerable assemblage of bone and pottery. It is tentatively suggested, therefore, that this feature was also employed as a dump following its abandonment (Robertshaw 1986: 7).

In terms of structural (i.e. non-artefactual) data, therefore, it would not be unreasonable to conclude that the 1982 season added little to the previous work undertaken by Sassoon. However, the post-excavation analyses carried out by the more recent project produced significant results and was able to incorporate Sassoon's ceramic archive, much of which had hitherto not been analysed. Thus, the earlier pottery typology was substantially revised, producing, through a combination of vessel forms, decoration and fabric, a ceramic series of seventeen pottery types (Robertshaw 1986: 9). This, unfortunately, could not be neatly seriated. Nevertheless, it is interesting to note that whilst a similar range of pottery forms were recovered from the three investigated hillside settlement sites and from various valley contexts, stone circle C1 (Sassoon 1966) contained four types not recovered from hillside locations (Robertshaw 1986: 16 table 3)[13]. Robertshaw therefore concludes that the long chronology should be rejected in favour of seeing all the investigated feature types as associated with a single ceramic tradition, but one in which the unique C1 forms belong to either an earlier or later element. To answer the question of the stone circles' relative chronological position within the site's phasing, Robertshaw defers to the radiocarbon data.

By first calibrating all the available radiocarbon dates, then rejecting the apparently anomalous first millennium results derived from Sassoon's A2 and the very late bone samples from A5, Robertshaw (1986: 17-18) argues that there is a clear clustering of radiocarbon figures around the mid-fifteenth to early nineteenth centuries, with the large date range partially explained as a product of so-called 'kinks' within the calibration curve employed (ibid., citing Stuiver 1982). However, three samples have calibrated date ranges that extend back beyond the mid-fifteenth century: the 'Hillside 2' samples GX-900 and M-1892 and the stone circle sample GX-247. GX-900, a charcoal sample from Sassoon's terrace A5, is quoted by Robertshaw as having an unknown margin of error, and therefore produces a much shorter calibrated date range than the other samples. Nevertheless, an early fifteenth century date for A5 seems more in keeping with the results from surrounding features than the very late determinations derived from the bone samples GX-742 and GX-743. M-1892 and GX-247, in contrast, both produce long potential date ranges when calibrated, with Robertshaw quoting one sigma figures of 1320-1470 cal AD for the stone circle sample, and 1320-1500 or 1620 cal AD for the sample from the terrace on Hillside 2 (Robertshaw 1986 citing Stuiver 1982). Given the unique pottery forms recovered from within C1, and Sassoon's belief that the recovered carbon samples were from deposits that post-date the structure's occupation, Robertshaw employs the radiocarbon results to suggest tentatively that the stone circle pre-dates the occupation of the hillside structures. Recalibrating M-1892 and GX-247 using the southern hemisphere curve produced by McCormac et al. (2004) generates a more ambiguous picture with M-1892 possibly as early as the late thirteenth century, whilst the stone circle sample is most likely to fall within the date range of 1380-1640 cal AD. Nevertheless, based on the information at his disposal,

[13] Designated types 11-14, all are straight sided beakers with incised linear decorations below the rim (Robertshaw 1986: 9, illustrated 14, figure 13). Type 13 corresponds to Sassoon's type 3 (1966: 86, illustrated 87 figure 3).

Robertshaw's tentative conclusion is reasonable and, moreover, his decision to reject the early hillside radiocarbon results is supported by a later suite of determinations commissioned by Siiriäinen and Laulumaa (Laulumaa pers. comm. – see below) which consistently produced dates of the late fifteenth century or later. The Helsinki dates therefore also tend to confirm Robertshaw's conclusion that the mid-seventeenth century may be the most appropriate date for the system's "*floruit*" (Robertshaw 1986: 17 citing Ottoway 1973).

In addition to the ceramic and radiocarbon analyses, a faunal examination was undertaken by Thorp (1986). Although Thorp points out that a detailed study of the management of the animal economy would require a considerably larger assemblage, several important preliminary conclusions are drawn. Based purely on the relative proportions of identified bones, sheep/goat constitute 80% of the faunal sample. If this is adjusted to account for the relative species frequency based on the minimum number of individuals represented (a method which can exaggerate the importance of less frequently recovered examples – Thorp 1986: 23, citing Grayson 1978), sheep/goat still make up 63% of the non-human osteological data. The remainder are cattle; no game species are represented in the 1982 faunal archive. Sheep/goat mortality rates peak at between 30 and 60 months, though Thorp sees the relatively high rate of early slaughter of animals under 16 months as suggestive of a management strategy similar to that practised in Western Sudan (Thorp 1986: 25 citing Dahl and Hjort 1978), whereby young males are culled and eaten to conserve sparse grazing for potentially productive females. The presence of adult and old individuals within the cattle assemblage also led Thorp to suggest tentatively that the bovine herd was kept on site, whilst the ages of cattle in the – admittedly small – sample might suggest that large stock were seen as being more valuable than sheep or goats and that cattle were perhaps viewed as a means of wealth accumulation. Despite the relatively large population of sheep/goat, their higher reproductive rate and considerably lower meat and milk yields are seen as evidence that cattle nevertheless formed a significant dietary component at Engaruka (Thorp 1986: 23 and 26).

The broad picture presented by the 1982 fieldwork, therefore, is one that correlates well with Sutton's survey-based interpretation and chronology (1978), with the exception that the stone circles are tentatively interpreted as the remnants of an earlier tradition that are perhaps later re-employed as corral features for the stall feeding of cattle and the accumulation of manure for fertiliser (Robertshaw 1986: 16-17; Thorp 1986: 26; Sutton 1986: 29). The different stone built features at the site are therefore interpreted as differing functional elements of a single economy. The hillside terraced enclosures are seen as representing houses, garden terraces and, in the case of the sunken hearth structures, possible meeting places or communal kitchens. Cairns are viewed from a simple functional perspective as field clearance features (Sutton 1986: 39-40); an interpretation that replaces the view that these features performed some defensive function. The sheer scale of the field systems (which are still viewed as being broadly contemporaneous) are thus interpreted as evidence that arable production formed the mainstay of the economy, with stock nevertheless employed as an integrated and essential element for this system's maintenance.

1982 – 2000

Since 1982 the archaeological study of Engaruka, and of other examples of African agricultural technology, has been dominated by the work of J.E.G. Sutton. This research builds primarily on the walkover surveys of the cultivation, irrigation and hydrological features carried out in 1971-2 (Sutton 1978), and combines this with discussions of the probable nature and date of the systemic operation of the site (Sutton 1984; 1986; 1999; 2000 [1998]; 2000; 2004). This work has also been expanded to archaeological, historiographical and ethnographic comparisons and gazetteers of analogous systems (Sutton 1985 and Grove and Sutton 1989); an approach that has been further employed to identify possible successor communities to the 'Engaruka Complex' (Sutton 1990 and Adams, Potnanski and Sutton 1994).

Although the interpretations and models of operation and abandonment drawn from the first of Sutton's surveys remain largely intact in later discussions, some amendments were suggested by follow-up visits made in 1982 and 1984 (Sutton 1984 and 1986). The rejection of the defensive view of the stone cairns and circles has been touched upon above, however, these later surveys also suggested that several areas within the field system had been modified, either as part of a process of refinement and expansion, or, as Sutton suspected, as the result of agricultural stress. In particular, attention is drawn to the 'great northern canal', as this feature can be seen to overlie older field lines at certain points along its length (for example Sutton 1986: 36). Similarly, by conjecturing the existence of a wooden channel manufactured in a manner analogous to that employed by the Marakwet (Soper 1983: 81), Sutton also agues that extensions of the irrigation system could have been periodically constructed without leaving substantial archaeological traces or necessitating the alteration of earlier stone alignments.

That this evidence of systemic modification is seen as indexical of falling soil fertility or of increased soil erosion is entirely within the tenets of Sutton's earlier discussions. Once again these models are not examined with reference to the broader narrative schemes outlined by

Malthus (1985 [1798]), Boserup (1965) or Geertz (1963), but the methodological influence of studies of prehistoric agricultural sites in the Pacific and Americas is acknowledged (Sutton 1986: 34-5 citing Farrington 1980 and 1985). In particular, the Engaruka surveys of the early 1980s re-examined elements of the irrigation system in order to attempt to model flow rates with the aim of estimating the total irrigable area; a technique previously employed by Farrington for sites in Peru. An appendix to Sutton's 1986 report by Adams summarises the results of a brief hydrological survey undertaken in September of the same year. Whilst Adams notes that "detailed data are not currently available on the seasonal variation in precipitation at Engaruka or in the catchment area" (Adams 1986b: 50) it is suggested that observations of modern furrows demonstrate that there are potential taphonomic indicators of flow rates in the form of gravel, or cobble-like, furrow base deposits. Adams also highlights the problem that, based on current evidence, the lower extant river levels (evidenced by off-takes now visible up to a metre above the current water level) need not be seen as indicative of diminished water volumes, but may instead represent down-cutting or lateral movement of the stream. In essence, then, Adams concludes that considerably more research in terms of producing topographical surveys of the field and irrigation system would be required, and that this would itself need to be contextualised through a more precise understanding of prevailing environmental conditions both now and during the time of systemic operation.

In addition to the recommendations for further work outlined above, Adams also suggested that research be undertaken on the contemporary irrigation system operated at Engaruka. This work has subsequently been undertaken by Bertelsen (1995), through an interview-based project that examined five contemporary irrigation systems within the immediate region of the current study area (Engaruka, Selela, and Mtu wa Mbu, including Kiruruma, Jangwani, and Migombani Chini) all of which had been either created or affected by Tanzania's centrally organised *ujamaa* 'villagisation' programme of the early 1970s. Specifically, the report outlines cropping and irrigation practices, as well as how these systems are organised in terms of labour, distribution of resources, and individual and collective responsibilities. It should be stressed that the project was never intended to act as a source of ethno-archaeological data, and describes systems that cannot be termed 'traditional'. Nevertheless, the interview evidence offers useful insights into the experiences of a community that has been farming the immediate environs of the archaeological site since the 1890s (Sutton 1978: 42 citing Schoeller 1901, Uhlig and Jaeger 1942; Reck 1926 and Gillman 1938), albeit one that has experienced considerable change in the last 30 years. For example, Bertelsen's study includes accounts of changing irrigation practices which are described as being a response to increased demand for water, thus offering a case study of particular interest in terms of Sutton's hydrological decline hypothesis. In terms of cropping practices, the situation described by Bertelsen of a maize and cluster bean based crop repertoire supplemented by banana, sweet potatoes, cassava and sorghum, appears to remain in place.

In 2000 the Dutch NGO SNV (originally Stichting Nederlandse Vrijwilligers, but now known simply as SNV Nederlandse Ontwikkelingsorganisatie or SNV Netherlands Development Organisation) constructed a concrete weir and furrows, along with a concrete charcoal filter connected to water pipes that lead to taps in communal areas, such as the two schools and the village dispensary. What effect the construction of these utilities has had on the water distribution system outlined by Bertelsen has not, to our knowledge, been studied[14]. Based on observation and informal interviews conducted by the current project in 2003, the weir and concrete furrows appear to have been incorporated into the pre-existing system of water management. Indeed, the incorporation of the concrete furrows into the system of water allocation means that they are frequently shut off when water is required elsewhere. This is clearly contrary to their design as still water pools in the sediment traps and quickly stagnates. In contrast, access to the piped water supply is unregulated and some farmers now employ this potable water for irrigation. Purchasing the materials necessary for connection (plumbing supplies and hose pipes) were described as the only restriction to access, and indeed some farmers are considering the construction of small reservoirs though at present the costs are seen as prohibitively high.

Figure 5.8

Modern concrete irrigation furrow constructed by SNV in 2000. Note silt trap in foreground.

In addition to carrying out the construction work described above, SNV initiated a cultural tourism programme which involved training members of the local community to act as guides to the archaeological site and to Maasai bomas, and to organise longer walking trips in the surrounding area. Fees for these services are negotiated by the guides.

[14] Although presumably SNV would have commissioned or carried out a report, requests for information from the organisation have not been successful.

Current research

As discussed above, in order to refine Sutton's model for the operation and abandonment of Engaruka, additional information is required including a better understanding of the extent of local and regional interaction; an enhanced appreciation of the site's internal chronology, and a more precise calculation of population size over time. These questions were identified as research priorities by a team led by Ari Siiriäinen, and prompted an initial walkover survey in 1996 (Siiriäinen, Koponen and Laulumaa ND citing Laulumaa & Koponen 1999). The walkover suggested to its participants that by combining the selected excavation of small areas across the entire breadth of the site with the taking of radiocarbon samples, it should be possible to trace the settlement development at Engaruka, and to relate this development to environmental factors. Thereafter the proposed methodology was to target additional excavations in the most promising areas, and to couple this with a regional survey at a radius of approximately 20 km around the site. Fieldwork started at Engaruka in September 2002, and the regional survey commenced in September 2003. The need to situate this research within a broader multidisciplinary study was identified at an early stage and, as such, a collaboration was agreed with both the BIEA and the University of Stockholm based 'Place, Land, and Time in Africa' (PLATINA) project (Siiriäinen, Westerberg, Lane and Stump 2002).

Clearly the conditions that prompted the development and eventual abandonment of Engaruka need not have been exclusively on-site, and may, in contrast, have been the result of regional, or even global, climatic changes. It is questions of this sort that the physical geographical contingent of the PLATINA project aim to address. Based on published lake core evidence (Nicholson 1998; Verschuern et al. 2000; Johnson et al. 2001) and current work by members of the project (Holmgren 2002; Muzuka, Ryner and Holmgren 2002; Ryner, Holmgren and Muzuka 2002; though see also Muzuka, Ryner and Holmgren 2004 who note the poor resolution of African lake core sequences for the Holocene), Westerberg suggests that the establishment and subsequent decline of Engaruka coincides with wetter than present conditions associated with the 'Little Ice Age'; a climatic trend dated to between the thirteenth and nineteenth centuries AD (Westerberg 2002a and b). In order to both refine the dating of this climatic phenomenon and relate it to Engaruka, it is proposed to carry out palaeoenvironmental sampling (principally palynology and diatom analysis) on the site and at the Engaruka Basin (a soda flat/lake located approximately 25km to the southwest of Engaruka and fed by the Engaruka river), and to combine this work with studies targeted towards assessing whether environmental deterioration in the catchments of the rivers that formerly fed the agricultural system would suggest hydrological decline (Westerberg 2002a).

Although a preliminary survey was undertaken in 2003, the proposed sampling programme has yet to be undertaken but is scheduled for early 2006.

Related to the question of hydrology is the issue of the apparent prioritisation of agriculture on the alluvial fans. Although these are stable geological features of probable Pleistocene origin, it is possible that these were periodically replenished with fertile alluvial sediments during the period of occupation (see excavation results below). Nevertheless, Westerberg (2002a) notes that the soils on these fans are considerably more coarse than the sediments below them, and that it is these lower sediments that are principally farmed today. One potentially useful avenue of research suggested by Westerberg is to examine whether fertile andosols (evidenced today only in relatively wet pockets within the alluvial fans) were once more widespread, and, if so, to question whether physical deterioration of these volcanic soils can be seen as a contributory factor in abandonment. It is known, for example, that the water retention of andosols can be irrevocably reduced by prolonged drought (ibid.). To place such studies in context, Westerberg further advocates that palaeopedological investigations be undertaken to examine the relative levels of soil fertility within the abandoned agricultural area. The initial stages of a study of this sort are reported upon here.

The first phase of the University of Helsinki fieldwork consisted of a detailed walkover survey and collection of surface finds aided by a recently commissioned satellite image of the site; the excavation of a stone circle to the immediate north of the Olemelepo; the excavation of three trial trenches into terraced features on the escarpment to the south of the Engaruka River; the insertion of two trenches placed in similar terrace structures adjacent to the 'intermediate north gorge'; the cutting-back of the bank of an erosion gully in the Northern Fields to retrieve pottery samples, and the mapping of the areas around the excavation sites (Siiriäinen, Laulumaa, Koponen and Seitsonen 2003a).

The stone circle was the first area to be investigated, and was chosen out of several such examples as it consisted of two adjoining enclosures which appeared, prior to excavation, to overlie earlier field divisions and irrigation features. Upon investigation, however, the two enclosures were interpreted as having been built in a single episode, whilst the stone lines were reinterpreted as probably dating to a phase of construction associated with the stone circle (Siiriäinen et al. 2003a: 3); an interpretation that was again revised following the examination of unexcavated examples and the investigation of another circle by the current project in 2003, which together indicate that the field and furrow lines post-date the stone circles, and in several instances furrows are either diverted around these enclosures or else run through dismantled sections of walls (Siiriäinen et al. 2004: 12-13). These findings thus support Robertshaw's ceramic and radiocarbon based assessment that the circular structures are comparatively early elements of the site and, as will be returned to below when the stone circle investigated by the current project is discussed, this conclusion has ramifications in terms of how land is perceived by the operating community, since it indicates that even small areas within pre-existing structures are later sub-divided.

In terms of excavation methodology, the interior of the larger of the two structures was divided into quadrants, two of which were then excavated in 150mm spits to a depth of 600mm, at which point a layer of pebbles and stones was encountered and excavation halted. Finds were located by 'layer' (spit) for depth, and via 1m x 1m sub-divisions for horizontal position. Excavation within the second enclosure (designated as 'Room B') was by means of a 4m x 2m trench, positioned so as to transect the double line of stones that were previously assumed to represent the remains of an earlier irrigation furrow (see figure 5.9). Of the two radiocarbon samples recovered from within deposits in Room A (Hela-715 and Hela-716, Laulamaa pers. comm.), the first calibrates to between the early fifteenth and early seventeenth century (McCormac et al. 2004), whilst the second probably dates to between the early seventeenth and early nineteenth century (ibid.). Clearly, in the absence of a sample from within the fabric of the structure, these dates need to be treated in the same way as both Sassoon (1966 and 1967) and Robertshaw (1986) dealt with the C1 determination (GX-247): by regarding them as simply post-dating the construction of the circle. With this in mind, Hela-715 would certainly seem to confirm that the stone circles are comparatively early structures within the inter-site chronology.

Figure 5.9: University of Helsinki stone circle excavation
(note furrow and stone lines in foreground)

By combining interpretation of the satellite image with on the ground survey, the team suggests that Sassoon's and Sutton's interpretation that the hillside structures consist of seven discernible nucleated villages requires revision, and argue instead that these terraces form a "more or less continuous zone of settlement" (Siiriäinen et al. 2003a: 3). They therefore propose to refer to areas within this zone by a sub-division into three sections: "South Section between the southern end of the zone up to the Engaruka river, Middle Section from there up to the so-called Intermediate Gorge, and North Section from there to the northern end of the zone" (ibid.: 4). Subsequent survey work in 2003 indicates that the total area of the settlement zone is approximately 37ha (Siiriäinen et al. 2004: 12).

The excavation within the 'South Section' targeted one of each of the three apparent terrace types: Trench 1 was a 2m x 2m sondage into the 'main' area of a 'habitation terrace'; Trench 2 was a 2m x 2m excavation into an example of the slightly elevated areas that are commonly seen in one corner of habitation terraces, whilst Trench 3 investigated the entire interior of an oval platform measuring approximately 3.6m x 3m. Because the stated aim of the excavation was to produce an artefactual assemblage that would permit intra-site comparisons and perhaps shed light on the internal chronology, the stratigraphy within these trenches is primarily presented to contextualise the finds. However, some stratigraphic information of relevance to the current study is presented, notably in reference to the hearth structure found within Trench 3 (figure 5.10). This feature is of the type identified during excavations by Leakey and Sassoon and, as with these earlier examples, is within a walled structure, the base of which consists of large sub-angular boulders. In the excavated example the base of these boulders, and hence of the wall itself, were encountered at 300mm below the current ground level, but finds of pottery, bone fragments, ostrich eggshell and glass beads where recovered to a depth of 700mm, which Siiriäinen et al. (2003a: 5) regard as "indicating a relatively recent age of the feature within the occupation period of the site". This conclusion, although based on a fairly direct correlation between depth of deposition and time, nevertheless serves to emphasise that the key to understanding the development of these habitation areas is through a thorough understanding of the internal stratigraphy, with the observation that the hearth seals a further 400mm of deposits indicating either successive or continued occupation of the terraced settlement zone (as favoured by Sassoon), or the expansion of the terraced area over former refuse and possibly even burial areas (as suggested above). Note, for example, that in figure 5.10 below, the southern wall of the structure that houses the hearth clearly abuts the reveting wall of the up-slope terrace on the right of the frame.

Figure 5.10: Hearth and associated terrace structure, University of Helsinki excavation 2002

Excavations within the 'North Section' (Sassoon's 'Hillside 7') of the habitation zone produced similar results in terms of finds and depositional sequence to those described in the south. However, a hearth uncovered within an oval structure in the northern village was partially removed to permit further excavation. Approximately 400mm below the paved area that surrounds the hearth, a further structure was encountered that has been tentatively interpreted as an earlier hearth. If this is indeed the case, these features would represent good evidence of either the prolonged or recurrent occupation of habitation sites. Although radiocarbon samples were taken from these two hearths they have yet to be processed. However, two determinations have been received from charcoal samples retrieved from Trench 1; a 2m x 2m trial pit excavated adjacent to the eastern revetting wall of a terraced habitation platform (Siiriäinen et al. 2003a: 5). These samples (Hel-4639 and Hel-4640) produced figures of 220±90 BP and 240±60 BP respectively (Laulumaa pers. comm.); dates which can be calibrated to no earlier than the late fifteenth (Stuiver et al. 1998) or early sixteenth (McCormac et al. 2004) centuries. Calibration via both these curves, however, indicates that the balance of probability suggests that these samples date to between the early seventeenth and nineteenth centuries. In contrast, of the six samples taken from the excavations within the southern section of the habitation zone (Sassoon's 'Hillside 2'), two (Hela-717 and Hela-722) produced calibrated dates between the fifteenth and seventeenth century (Stuiver and Kra 1986; Stuiver et al. 1998; McCormac et al. 2004), with the four later dates (Hela-718, Hela-719, Hela-720 and Hela-721) all originating from samples retrieved from layers higher up in the depositional sequence (Laulumaa pers. comm.), and all calibrate to the late seventeenth century or later.

The combined excavations of the habitation sites and the stone circle produced a considerable assemblage of ceramics (2168 sherds weighing 12.5kg), of which over half were recovered from the southern habitation zone excavations (Oteyo 2003: 8). Although detailed analysis of this assemblage has yet to be undertaken, the cataloguing of the material is complete and demonstrates that the 2002 collection contains most of the pottery types previously identified by Sassoon and Robertshaw and does not contain any additional forms (Oteyo 2003: 11) though various deposits within the southern habitation zone contained sherds decorated with punctates that do not appear to have close parallels in the assemblages collected by Sassoon and Robertshaw. In Oteyo's opinion there is no reason to regard the differences of pottery styles as representing different technical or 'cultural' traditions but, as noted by Sassoon (1966: 95; 1967: 216) and – with some slight modifications – Robertshaw (1986: 14), there are forms from the stone circle contexts that do not occur in the assemblages from the habitation zones; a observation that prompts Siiriäinen et al. (2003a: 7) to comment that "due to the obvious typological differences in the respective pottery assemblages found from these features it is quite possible that the stone circles date to the initial phase of the occupation of Engaruka".

By mapping two areas within the settlement sites and noting that differences in function can be predicted by the size and shape of terrace structures in plan, Siiriäinen et al. (2003a) were able to record the density of terraces, and the relative ratios of features thought to represent habitation platforms, garden plots, and those which probably contain hearths. The density figures were then employed to estimate the total number of such structures, and thus aid in producing approximate population figures. In the southern section a plan of an 80m x 60m area demonstrated a ratio of 6 houses per hearth, whereas in the north a smaller sample of an area 60m x 40m records a ratio of 10:1. Allowing for the fact that different ethnographic analogies demonstrate different average household sizes, Laulumaa (2003 and 2004) suggests that these ratios, when combined with a figure for the total area of the habitation zones derived from ground survey and GIS analysis of the satellite image, produce a maximum population figure of between 14,000 and 19,000. Although it should be stressed that Laulumaa has yet to suggest what he feels would be an appropriate figure for minimum population, the maximum figures offered would suggest the agricultural system was capable of supporting a population density of between 700-950 people/km^2. By way of comparison, Sutton's earlier approximation based on an estimate of terrace numbers and average household sizes at Sonjo, produced a figure of roughly 5000 or a population density of 250 people/km^2 (Sutton 2000), whilst Koponen (1988: 240) cites figures of between 1.6 and 2.3 people/km^2 for citemene-style shifting agriculture; 154 people/km^2 for the Chagga system of irrigated banana cultivation on Mount Kilimanjaro, and 300 people/km^2 for the late nineteenth-century terraced and irrigated system on Ukara Island (Koponen 1988: 235 citing Hermann 1893).

Of course, as with earlier estimates offered by Sassoon and Sutton, Laulamaa's population figures assume that all the habitation terraces were occupied simultaneously. However, whilst Sutton acknowledges that this assumption requires confirmation or refutation and stresses that population estimates should be cross-referenced to crop-yield approximations, Siiriäinen et al. argue that the apparent lack of any clear typological differences in the recovered artefact types from the various excavated settlement sites is indicative of a simultaneous occupation of all of the habitation zone. The similarity in terrace construction and form, as well as the proposed revision of the nucleated village view of settlement pattern, are, it is argued, entirely consistent with this view. Indeed, although it is accepted that the results are not definitive, they assert that:

> This conclusion of the contemporaneity of the habitation would not mitigate the possibility that some section or sections of the zone would have been abandoned while some other section or sections were still inhabited, but we feel that such a case is rather improbable.
>
> (Siiriäinen et al. 2003a: 7)

This conclusion would seem, at present, to be a little premature, since there is no reason to expect changes in ceramic or building styles during the lifetime of the site, and indeed it needs to be considered that Robertshaw (1986) interpreted one of the five terrace platforms excavated in 1982 to have been later re-employed as a refuse area, whilst Sassoon (1967) felt that several excavated terraces represented the remains of garden plots. These two observations alone would seem to be sufficient to require a qualification of the population estimate. Moreover, even if the entire habitation zone was eventually fully occupied, this information remains relatively unhelpful without an understanding of the time-frame during which the community expanded, since in the absence of this data it is impossible to assess whether the agronomy was sustainable for this maximum density of population. Like Sassoon and Robertshaw before them, Siiriäinen et al. (2003a: 6) suggest that radiocarbon dating offers the best means to address this problem, and assert that the results of these samples will "clarify the chronological disposition of the site". Yet, regardless of problems with calibrating what are all relatively late dates in radiocarbon terms, there are several evident difficulties that limit further analysis of the available radiocarbon data.

Figure 5.11: Engaruka radiocarbon determinations (After Sassoon 1966, 1967, 1971; Robertshaw 1986 and Laulumaa pers. comm.)
The 1964 excavation (Sassoon 1966, 1967, 1971 and Robertshaw 1986)

Sample ID	Location & depth	Age (BP)	Calibrated dates (cal AD) with relative probability of range in brackets						
			Robertshaw 1986 using Stuiver 1982	OxCal v2.18 (Stuiver and Kra 1986)		Calib v4.4.2 Intcal98 (Programme Stuiver and Reimer 1993) (Curve: Stuiver et al. 1998)		Calib v4.4.2 SHCal02 Southern Hemisphere (McCormac et al. 2004)	
			1 sigma	68.2% confidence	95.4% confidence	68.3% confidence	95.4% confidence	68.3% confidence	95.4% confidence
GX-247	Stone circle C1 45-60cm	490 ± 90	1320-1350 1380-1470	1300 (0.27) 1360 1380 (0.73) 1490	1280 (0.88) 1530 1550 (0.12) 1640	1310 (0.21) 1360 1380 (0.75) 1490 1602 (0.03) 1610	1290 (0.86) 1530 1550 (0.14) 1630	1390 (0.82) 1510 1580 (0.18) 1620	1320 (0.05) 1360 1380 (0.95)1640
GX-347	Terrace A2 30-45 cm 'Hill 3'	1230 ± 120	650-980	660 (1.00) 900	600 (1.00) 1030	680 (0.95) 900 920 (0.05) 940	600 (1.0) 1030	690 (0.1) 700 710 (0.12) 750 760 (0.60) 910 910 (0.27) 990	640 (0.97) 1050 1080 (0.2) 1120 1120 (0.1) 1140
GX-348	Terrace A2 45-60 cm 'Hill 3'	1620 ± 90	270 320-540	260 (0.03) 280 330 (0.97) 550	220 (1.00) 620	260 (0.02) 270 340 (0.98) 540	240 (1.00) 620	400 (0.95) 580 580 (0.05) 600	260 (0.03) 280 280 (0.01) 300 320 (0.96) 650

Figure 5.11 (continued): Engaruka radiocarbon determinations
The 1966 excavation (Sassoon 1967, 1971 and Robertshaw 1986)

Sample ID	Location & depth	Age (BP)	Calibrated dates (cal AD) with relative probability of range in brackets						
			Robertshaw 1986 using Stuiver 1982	OxCal v2.18 (Stuiver and Kra 1986)		Calib v4.4.2 Intcal98 (Programme Stuiver and Reimer 1993) (Curve: Stuiver et al. 1998)		Calib v4.4.2 SHCal02 Southern Hemisphere (McCormac et al. 2004)	
			1 sigma	68.2% confidence	95.4% confidence	68.3% confidence	95.4% confidence	68.3% confidence	95.4% confidence
GX-742	Terrace A5 165cm	<70	NA	NA	NA	NA	NA	NA	NA
GX-743	Terrace A5 200cm	<160	NA	NA	NA	NA	NA	NA	NA
GX-900	Terrace A5 165cm	505 ± ?	1420	1416 (1.00) 1425	1411 (1.00) 1430	NA	NA	NA	NA
UCLA-1615A	Terrace A5 120-135cm 'Hill 2'	320 ± 60	1450-1650	1490 (1.00) 1640	1440 (1.00) 1670	1490 (0.07) 1510 1510 (0.73) 1600 1610 (0.20) 1640	1440 (0.99) 1670 1780 (0.01) 1790	1500 (0.67) 1600 1610 (0.30) 1660 1660 (0.03) 1670	1460 (0.89)1680 1730 (0.11) 1800
UCLA-1615C	Terrace A5 60-75cm 'Hill 2'	250 ± 60	1530-1670 1750-1800	1510 (0.36) 1590 1620 (0.34) 1680 1740 (0.30) 1800	1470 (0.68) 1700 1720 (0.27) 1820 1850 (0.01) 1880 1920 (0.04) ……	1520 (0.33) 1590 1620 (0.38) 1680 1760 (0.24) 1800 1930 (0.05) 1950	1480 (0.66) 1700 1720 (0.26) 1810 1840 (0.02) 1880 1910 (0.06) 1950	1620 (0.40) 1700 1720 (0.54) 1810 1930 (0.06) 1950	1510 (0.11) 1587 1620 (0.73) 1820 1830 (0.08) 1890 1900 (0.08) 1950
M-1892	Terrace A10 105cm 'Hill 2'	470 ± 110	1320-1350 1380-1500 1620	1310 (0.16) 1360 1380 (0.72) 1520 1590 (0.12) 1630	1280 (1.00) 1650	1320 (0.10) 1350 1390 (0.73) 1520 1580 (0.17) 1630	1290 (1.00) 1650	1400 (0.64) 1510 1540 (0.36) 1620	1290 (0.99) 1670 1780 (0.01) 1800
M-1893	Terrace A19 90cm 'Hill 2'	300 ± 100	1450-1670 1750-1800	1460 (0.98) 1670 1780 (0.02) 1790	1420 (0.78) 1700 1720 (0.19) 1880 1910 (0.03) ……	1460 (0.95) 1670 1780 (0.05) 1800	1430 (0.78) 1700 1720 (0.14) 1820 1830 (0.04) 1880 1910 (0.04) 1950	1480 (0.01) 1490 1490 (0.74) 1680 1730 (0.25) 1800	1450 (0.88) 1820 1830 (0.06) 1890 1900 (0.01) 1910 1910 (0.05) 1955
M-1894	Oval enclosure A21 *c*15cm 'Hill 2'	200 ± 100	1530-1910	1630 (0.89) 1890 1910 (0.11) …….	1508 (1.00) ……	1640 (0.26) 1700 1720 (0.42) 1820 1820 (0.18) 1880 1910 (0.14) 1950	1490 (0.01) 1500 1500 (0.14) 1600 1610 (0.85) 1950	1650 (0.24) 1710 1710 (0.42) 1810 1830 (0.21) 1890 1920 (0.13) 1950	1510 (0.05) 1550 1550 (0.02) 1580 1620 (0.93) 1950

Figure 5.11 (continued): Engaruka radiocarbon determinations
The 1982 excavation (Robertshaw 1986)

Sample ID	Location & depth	Age (BP)	Calibrated dates (cal AD) with relative probability of range in brackets						
			Robertshaw 1986 using Stuiver 1982	OxCal v2.18 (Stuiver and Kra 1986)		Calib v4.4.2 Intcal98 (Programme Stuiver and Reimer 1993) (Curve: Stuiver et al. 1998)		Calib v4.4.2 SHCal02 Southern Hemisphere (McCormac et al. 2004)	
			1 sigma	68.2% confidence	95.4% confidence	68.3% confidence	95.4% confidence	68.3% confidence	95.4% confidence
HAR-5475	Oval enclosure E 10-20cm 'Hill 3'	190 ± 80	1630-1920	1640 (0.25) 1700 1720 (0.64) 1880 1910 (0.12)	1515 (0.09) 1595 1620 (0.91)	1640 (0.23) 1700 1720 (0.45) 1820 1830 (0.16) 1880 1910 (0.16) 1950	1520 (0.07) 1590 1620 (0.93) 1950	1670 (0.20) 1710 1710 (0.44) 1810 1830 (0.22) 1880 1920 (0.14) 1950	1530 (0.01) 1540 1620 (0.99) 1950
HAR-5476	Oval enclosure E 50-70cm 'Hill 3'	280 ± 90	1470-1660 1750-1800	1470 (0.90) 1670 1760 (0.10) 1800	1430 (0.75) 1700 1720 (0.22) 1880 1910 (0.03)	1480 (0.90) 1670 1770 (0.09) 1800 1940 (0.01) 1950	1440 (0.74) 1700 1720 (0.17) 1820 1830 (0.04) 1880 1910 (0.05) 1950	1500 (0.34) 1600 1610 (0.32) 1690 1720 (0.32) 1810 1940 (0.02) 1950	1460 (0.01) 1470 1470 (0.84) 1820 1830 (0.08) 1890 1900 (0.07) 1950
HAR-5477	Terrace platform C 165-180cm 'Hill 3'	220 ± 80	1520-1810 1930	1520 (0.15) 1570 1620 (0.30) 1700 1720 (0.42) 1820 1850 (0.05) 1870 1920 (0.09)	1490 (1.00)	1520 (0.10) 1560 1630 (0.30) 1700 1720 (0.41) 1820 1850 (0.06) 1870 1910 (0.13) 1950	1490 (0.18) 1600 1610 (0.71) 1900 1900 (0.11) 1950	1640 (0.28) 1710 1720 (0.46) 1820 1830 (0.10) 1860 1860 (0.05) 1880 1930 (0.11) 1950	1510 (0.04) 1550 1550 (0.02) 1580 1620 (0.94) 1950

Figure 5.11 (continued): Engaruka radiocarbon determinations
The 2002 University of Helsinki excavation (Laulumaa pers. comm.)

Sample ID	Location	Layer	Age (BP)	Calibrated dates (cal AD) with relative probability of range in brackets					
				OxCal v2.18 (Stuiver and Kra 1986)		Calib v4.4.2 Intcal98 (Programme: Stuiver and Reimer 1993) (Curve: Stuiver et al. 1998)		Calib v4.4.2 SHCal02 Southern Hemisphere (McCormac et al. 2004)	
				68.2% confidence	95.4% confidence	68.3% confidence	95.4% confidence	68.3% confidence	95.4% confidence
Hel-4639	1 N.V. square D 'Hill 7'	layer 7	220 ± 90	1520 (0.16) 1580 1620 (0.28) 1700 1720 (0.40) 1820 1840 (0.07) 1880 1920 (0.09) ……	1480 (1.00) …….	1520 (0.12) 1560 1620 (0.28) 1700 1720 (0.38) 1820 1830 (0.10) 1880 1910 (0.12) 1950	1490 (0.20) 1600 1600 (0.70) 1900 1900 (10) 1950	1640 (0.27) 1710 1710 (0.43) 1810 1830 (0.18) 1880 1920 (0.12) 1950	1510 (0.09) 1590 1620 (0.91) 1950
Hel-4640	1 N.V. square D 'Hill 7'	layer 5	240 ± 60	1520 (0.24) 1580 1620 (0.35) 1680 1740 (0.38) 1810 1930 (0.03)…….	1480 (0.60) 1700 1720 (0.35) 1880 1910 (0.05) ……	1520 (0.18) 1560 1620 (0.37) 1680 1730 (0.38) 1800 1930 (0.07) 1950	1480 (0.58) 1700 1720 (0.30) 1820 1830 (0.04) 1880 1910 (0.08) 1950	1630 (0.36) 1700 1720 (0.56) 1810 1930 (0.08) 1950	1510 (0.05) 1550 1560 (0.01) 1570 1620 (0.73) 1820 1820 (0.11) 1900 1900 (0.10) 1950
Hela-715	Stone Circle 101/500	layer 4	415 ± 50	1430 (0.93) 1520 1600 (0.07) 1620	1410 (0.77) 1530 1550 (0.23) 1640	1430 (0.87) 1520 1600 (0.13) 1620	1410 (0.72) 1530 1550 (0.28) 1630	1450 (0.59) 1510 1550 (0.03) 1560 1580 (0.38) 1620	1440 (1.00) 1630
Hela-716	Stone Circle 104/496	layer 2	225 ± 40	1640 (0.40) 1680 1740 (0.60) 1800	1520 (0.07) 1580 1620 (0.37) 1700 1720 (0.51) 1820 1920 (0.05) ……	1640 (0.47) 1680 1760 (0.45) 1800 1930 (0.08) 1950	1520 (0.05) 1570 1620 (0.39) 1700 1720 (0.46) 1810 1910 (0.10) 1950	1650 (0.27) 1690 1730 (0.73) 1800	1640 (0.28) 1720 1729 (0. 57) 1820 1830 (0.07) 1890 1920 (0.08) 1950
Hela-717	1 S.V. square D 'Hill 2'	layer 5	315 ± 40	1510 (1.00) 1640	1470 (1.00) 1650	1510 (0.79) 1600 1620 (0.22) 1640	1480 (1.00) 1650	1510 (0.45) 1550 1550 (0.19) 1580 1620 (0.36) 1650	1480 (0.98) 1670 1760 (0.005) 1770 1780 (0.015) 1800
Hela-718	1 S.V. square C 'Hill 2'	layer 4	185 ± 40	1650 (0.23) 1690 1730 (0.67) 1810 1930 (0.10) ……	1640 (0.89) 1880 1910 (0.11) ……	1660 (0.18) 1680 1730 (0.67) 1810 1930 (0. 15) 1950	1640 (0.22) 1704 1720 (0.53) 1820 1830 (0.09) 1890 1910 (0.16) 1950	1670 (0.24) 1710 1720 (0.22) 1760 1760 (0.07) 1780 1790 (0.09) 1810 1830 (0.14) 1860 1860 (0.08) 1880 1930 (0.16) 1950	1660 (0.58) 1820 1820 (0.22) 1890 1900 (0.20) 1950

Figure 5.11 (continued): Engaruka radiocarbon determinations
The 2002 University of Helsinki excavation (Laulumaa pers. comm.)

Sample ID	Location	Layer	Age (BP)	Calibrated dates (cal AD) with relative probability of range in brackets					
				OxCal v2.18 (Stuiver and Kra 1986)		Calib v4.4.2 Intcal98 (Programme Stuiver and Reimer 1993) (Curve: Stuiver et al. 1998)		Calib v4.4.2 SHCal02 Southern Hemisphere (McCormac et al. 2004)	
				68.2% confidence	95.4% confidence	68.3% confidence	95.4% confidence	68.3% confidence	95.4% confidence
Hela-719	2 S.V. square B 'Hill 2'	layer 3	175 ± 40	1660 (0.22) 1690 1730 (0.65) 1810 1910 (0.12)	1650 (0.88) 1890 1910 (0.12)	1660 (0.18) 1690 1730 (0.63) 1810 1920 (0.19) 1950	1650 (0.20) 1710 1710 (0.51) 1820 1820 (0.12) 1890 1910 (0.17) 1950	1670 (0.25) 1710 1710 (0.14) 1740 1800 (0.09) 1820 1830 (0.30) 1890 1920 (0.22) 1950	1670 (0.42) 1790 1900 (0.58) 1950
Hela-720	2 S.V. square D 'Hill 2'	layer 2	140 ± 40	1670 (0.35) 1750 1800 (0.47) 1880 1910 (0.18)	1660 (1.00)	1670 (0.16) 1700 1720 (0.26) 1770 1770 (0.04) 1780 1800 (0.08) 1820 1830 (029) 1880 1910 (0.15) 1940 1940 (0.02) 1950	1660 (0.45) 1780 1790 (0.38) 1900 1900 (0.17) 1950	1700 (0.17) 1720 1800 (0.08) 1820 1820 (0.48) 1890 1890 (0.27) 1940	1670 (0.25) 1740 1800 (0.75) 1950
Hela-721	3 S.V. section A 'Hill 2'	layer 6	120 ± 40	1680 (0.34) 1740 1800 (0.54) 1890 1910 (0.11) 1930	1670 (0.36) 1770 1795 (0.64)	1680 (0.32) 1730 1800 (0.55) 1890 1910 (0.12) 1930 1940 (0.01) 1950	1670 (0.38) 1780 1800 (0.60) 1940 1940 (0.02) 1950	1700 (0.13) 1720 1810 (0.26) 1840 1850 (0.15) 1870 1870 (0. 46) 1930	1680 (0.20) 1730 1800 (0.80) 1950
Hela-722	3 S.V. section A 'Hill 2'	layer 3	365 ± 40	1450 (0.62) 1520 1580 (0.38) 1630	1440 (1.00) 1640	1460 (0.50) 1530 1570 (0.50) 1630	1440 (0.49) 1530 1540 (0.51) 1640	1500 (0.86) 1600 1610 (0.14) 1630	1460 (0.03) 1470 1470 (0.97) 1640

Summary and discussion: persistent problems of site chronology

Whilst there is no doubt on the basis of recovered artefacts and carbon samples that the site belongs to the Late Iron Age, these sources of evidence have thus far failed to solve the issue of site development. Thus, while the imported glass beads in the finds assemblages from the stone circles and habitation areas certainly date to the second millennium AD, these are of persistent forms and do not, therefore, assist in the definition of an intra-site chronology. Similarly, although the pottery includes forms, fabrics and decorative motifs that are recognisably Late Iron Age, the vessels themselves do not represent exact parallels with those found elsewhere in the region, and thus cannot be dated by reference to other better understood site assemblages (Sutton 2004: 129, though recent preliminary petrographic comparisons between pottery fabrics and clay sources from Engaruka, Sonjo and Kondoa may, in due course, suggest possible areas for further work – Doherty 2004). As noted above, much has therefore been made of the possibility of phasing the site via radiocarbon dating; an approach that will undoubtedly play a part in reaching an understanding of Engaruka's development but the radiocarbon determinations commissioned thus far are insufficient to allow definitive statements regarding either the development or abandonment of the site. There are several reasons for this.

Firstly, the various excavations have produced just 24 dates, of which 13 are from the habitation zone that overlooks the Central Fields area (Sassoon's 'Hillside 2'; Siiriäinen et al.'s 'Southern Section'), and there is thus a serious sampling bias in favour of the central area of the site. Secondly, there is a question of lack of control: with only a very limited understanding of the sequence of expansion within the various habitation areas, there is no way of discerning whether a sample is representative of a given sub-area as a whole or simply dates an element of it. Note, for example, that the samples collected by the University of Helsinki project from the Southern Section of the habitation zone were all retrieved from terraces located on the eastern limit of this area, whereas the two samples taken from the Northern Section were recovered from platforms situated at the up-slope, western extent of the settlement. Since abutting relationships between terraces seem to indicate a tendency towards down-slope expansion within settlement areas, it is therefore possible that the radiocarbon dates refer to an early period of the northern settlement site, and to a late element of the village in the southern section. Of perhaps greater concern in terms of establishing an internal chronology of site development is the fact that at present there is still no way of distinguishing an extended period of occupation from successive periods of re-occupation.

That having been said, and having acknowledged the bias resulting from the greater number of samples from the area of habitation to the immediate south of the Engaruka river, it is noteworthy that the three samples from the south and north of the habitation zone (M-1894 from Sassoon's 'Hillside 1', and Hel-4639 and Hel-4640 from the area corresponding to Sassoon's 'Hillside 6') all calibrate to the early seventeenth century or later. If one discounts the very early dates received from GX-742 and GX-743, of the remaining three determinations from the habitation area to the immediate north of the Engaruka (Sassoon's 'Hillside 3'), two produced calibrated dates of the early seventeenth century or later, whilst Har-5476 may be as early as the late fifteenth century. In contrast, the 'village' site to the immediate south of the Engaruka produced five samples that are almost certainly earlier than the late seventeenth century cal AD (GX-900, UCLA-1615a, M-1892, Hela-717 and Hela-722), and six (as before, with the addition of M-1893) which may be fifteenth century, or, in the case of M-1892, up to a century earlier. Of the three stone circle samples, two calibrate to the early seventeenth century or earlier, with Hela-715 probably being no older than 1440 cal AD, whilst GX-247 is unlikely to pre-date 1380 cal AD (McCormac et al. 2004).

Viewed as a group, therefore, the available radiocarbon dates offer a broad picture of the period of occupation, and can be employed to suggest tentatively an intra-site chronology. Since the stone circle samples were retrieved from deposits that probably post-date the buildings' construction episodes, the conclusion that these features date to an early phase of occupation seems reasonable (Robertshaw 1986: 17 and Siiriäinen et al. 2003a: 3 and 2004: 12-13). Nevertheless, on the basis of the radiocarbon evidence it would seem that these structures may be broadly contemporary with the occupation of the lower slopes of the escarpment, at least in the area to the immediate south of the Engaruka river. Thereafter, the relatively early carbon sample from 'Hillside 3' (Har-5476) could be used to suggest provisionally that the area of settlement initially expands northwards, occupying the slopes to the immediate north of the Engaruka river. Further expansion continues north from this point, and southwards from the original settlement area on 'Hillside 2', with the radiocarbon samples M-1894, Hela-4639 and Hela-4640 suggesting occupation of the outlying areas by sometime after the early seventeenth century. This is, of course, a very generalised model as it is possible (Sutton would argue probable – see for example Sutton 2004) that the villages were established as individual settlements and later expanded towards each other, and indeed Sutton (2004) suggests on the basis of apparent relationships between habitation terraces, field divisions and the 'great northern canal', that the villages on either side of the 'Intermediate North Gorge' (Hillsides 6 and 7) were constructed prior to those above this major water channel (Hillsides 4 and 5). Nevertheless, in the broadest terms, this centre to periphery model of settlement expansion fits with the available evidence.

If the radiocarbon chronology still lacks sufficient detail to phase the site, it nevertheless gives a reasonable indication of the period of the site's occupation, and indeed the more recent determinations would seem to support the approximate dates of inception and abandonment suggested by Sutton (1978: 38) of the fifteenth to eighteenth centuries, with the latter date suggested more by the site's comprehensive abandonment prior to the first European accounts than by the radiocarbon data. Laulumaa's (pers. comm.) suggestion that occupation continued into the early nineteenth century cannot be completely discounted however, and neither can the possible fourteenth century dates suggested by the calibration of GX-247 and M-1892. Nevertheless, there would seem to be a broad consensus as regards dating, and general agreement as to the nature of the economy as one based on the irrigated production of sorghum supplemented, and indeed supported, by the keeping of small stock and cattle. The trajectory of the economy's development produces no such consensus, however, with Siiriäinen et al. (2003a: 7) suggesting that it developed to exploit opportunities to supply caravan traffic between the coast and Nyanza, whilst Sutton (for example 1978; 1989b) argues that it probably developed in relative isolation. Correspondingly, the cause of abandonment could be explained in terms of cessation of this trade-based raison d'être, or as due to, or at least exacerbated by, changes to the local environment, whether as a direct consequence of the actions of the community or as a result of broader climatic trends. Of these environmental factors, Sutton's later work (for example 1999; 2000 [1998]; 2000; 2004) has favoured a decline in the discharge of the rivers feeding the irrigation system, but over exploitation of land and water resources as a result of population pressure has also been suggested. Whether or not a climatic change towards drier conditions coincided with Engaruka's abandonment is not clear, but climatic shifts relating to the 'Little Ice Age' coincided with Engaruka's period of existence, and may have had some bearing on its abandonment (Westerberg 2002a).

The combined results of the studies outlined above suggest that the land-use system employed at Engaruka was sufficiently intensive to support a comparatively large number of people, with population estimates ranging from 4000 to 19,000, corresponding to a population density of between 250 and 900 people/km^2. With figures of this magnitude, it is little wonder that development planners are interested in exploring the potential of reapplying local agricultural knowledge, yet these figures must remain conjectural until such time when the occupation of the habitation areas can be phased with confidence. Similarly, without a thorough understanding of the causes of abandonment it is somewhat premature to regard the site as evidence of the misuse of local resources and as having "ended in a complete cul-de-sac" (Koponen 1988: 383). It is thus too early to subscribe to the simplistic formula that sees abandoned systems as failed systems, and to assume that "people sowed the seeds of their own destruction through their folly, for example by developing irrigation systems that caused salinization, or by stripping the landscape for fuelwood, or by allowing their livestock to over-graze the vegetation" (Barker and Gilbertson 2000b: 4). Yet, as Barker and Gilbertson go on to observe, "In general, the debate has been characterized more by confident assertions than well-founded argument" (ibid.). Archaeological techniques offer an opportunity to examine the validity of these beliefs in specific instances. The fieldwork reported upon below represents a preliminary attempt to do so by building on the results of the previous and current projects summarised above. Thus, whilst earlier excavations have understandably focussed on the habitation areas since these offer the best opportunities for the retrieval of finds, the current project targeted the field and irrigation system with a view to examining how these features developed and operated, and thus aimed to refine the picture of these features presented by Sutton's survey work.

The 2001-2003 investigations

Methodology

The work reported upon here consists of three elements: a preliminary walkover and soil sampling programme conducted in August 2001 (Stump 2003); two short seasons of excavation undertaken in September to October 2002 and October to November 2003, and the collection of a second set of soil samples following the 2003 excavation. The soil analyses are broadly based on those employed by Homburg and Sandor for a project with similar objectives undertaken in the Safford Basin, Arizona, USA in 1997 (Homburg and Sandor n.d.; Homburg et al. 1999) and involved the taking of 100g samples which were then divided into 10g sub-samples to test for soil reaction (pH), exchangeable calcium, exchangeable magnesium, exchangeable potassium, extractable phosphorous, total nitrogen, total phosphorus and total organic carbon. However, the 62 samples taken in 2001 – 2003 must be seen as merely a preliminary study, and indeed following a brief visit to the site in 2002 Homburg (pers. comm.) recommended that an area the size of Engaruka would warrant at least 500 on-site samples with an equal number of controls, though a sample-set of twice that size was considered preferable. The locations of these samples and the significance of the chosen suite of chemical analyses are outlined within the results section below. In brief, though, sample locales prioritised areas of formerly irrigated fields, and were taken with the intention of testing the hypothesis that abandonment of the agronomy can be linked to soil exhaustion associated with prolonged intensive cultivation, or with salinisation as a result of extended periods of irrigation. The colour of each sample was noted by reference to a *Munsell Soil Color Chart*. Texture and wet consistency were recorded, and the type and proportion of inorganic and organic inclusions noted. Relevant notes regarding the location of each sample, such as proximity to archaeological features, were also made.. Sample numbers are signified here by enclosing them in 'diamond' brackets <thus>.

Unlike the approach used in previous excavations at the site, the methodology employed by the current project avoided the excavation of arbitrary 'units' or spits, in favour of an episode-based recording system that attempted to define stratigraphic relationships within an area contextualised through survey. Seen in this light, the excavation methodology is perhaps best viewed as an evaluation exercise as it was not intended to remove totally all anthropogenic deposits within an arbitrary area. The recording methodology therefore represents a hybrid of the single context planning system commonly used in areas of total excavation, with a section based schema designed for targeting stratigraphic relationships at points of intersection. Deposits, or the removal of deposits, judged by the excavating archaeologists to constitute single events were assigned unique reference numbers (referred to here as 'context numbers') and recorded on individual pro-forma sheets. The truncation of deposits such as the excavation of a ditch are referred to here as 'cuts' and are signified by square brackets [thus]. Deposits are signified by round brackets (thus). Wherever possible contexts were removed in sequence (i.e. in the reverse order of their deposition). Where more than one section was excavated through a single feature these were contexted separately, though where appropriate these groups are referred to by the number assigned to their main constituent. Contexts were then combined within a stratigraphic matrix to produce a sequence of events. All recording was assimilated into a relational archive, with individual reference numbers for contexts, plans, sections, photographs and samples cross referenced. Artefacts are located by reference to the context number of the deposit from which they were recovered. The ceramic finds from the current project were catalogued and compared by Gilbert Oteyo alongside those from the University of Helsinki excavations.

Plans and sections were drawn by hand on drafting film at an appropriate scale (1:10 or 1:20 for sections, and 1:50 for plans). All drawings were located to an arbitrary north-south aligned grid, itself located by global positioning satellite (GPS) readings taken along its baseline. GPS readings were also used to create temporary benchmarks from which the relative heights of all features and their related scaled drawings were recorded. An area of approximately 100m by 30m around the principal excavation area was planned by hand at 1:50. To contextualise this, the surrounding area for approximately 1km² was mapped using a total station laser theodolite (referred to hereafter as an electronic distance measurer or EDM). This survey principally mapped archaeological rather than topographical features and planned these structures as distinct entities, rather than through recording the positions of their constituent parts. The intention here was to produce a generalised survey of agricultural structures, as opposed to an archaeological plan readily susceptible to stratigraphic phasing. The resultant plan is viewed as having a conceptual scale of not less than 1:5000. The EDM plan was then located within the landscape recorded by the 1964 aerial photographic survey and the satellite image of 2002.

The fieldwork results are therefore presented and discussed at three scales, the first comprising the excavation of a group of agricultural terraces and associated irrigation features in the North Fields area; the second consisting of the larger EDM survey and the excavation of two furrow junctions to the west of the main excavation, whilst the third includes a discussion of the development of Engaruka and outlines the results and implications of the chemical soil analyses. Although the excavation results will be discussed in some detail by examining the stratigraphic relationships between individual features, this detail is warranted since the field areas have not been excavated previously, and because to not do so would be to miss an opportunity provided by the unusually high archaeological visibility of the field systems at Engaruka.

Fieldwork results

The main excavation area focussed on a large irrigation channel with associated low terraced fields located in the North Fields area, roughly midway between the Engaruka and Makuyuni Rivers and centred at approximately 2°50'16" S, 35°57'27"E. This feature, designated context [1], was partially revealed by erosion which threatens its preservation, and was thus felt to be one of several such features that should be investigated as a matter of priority.

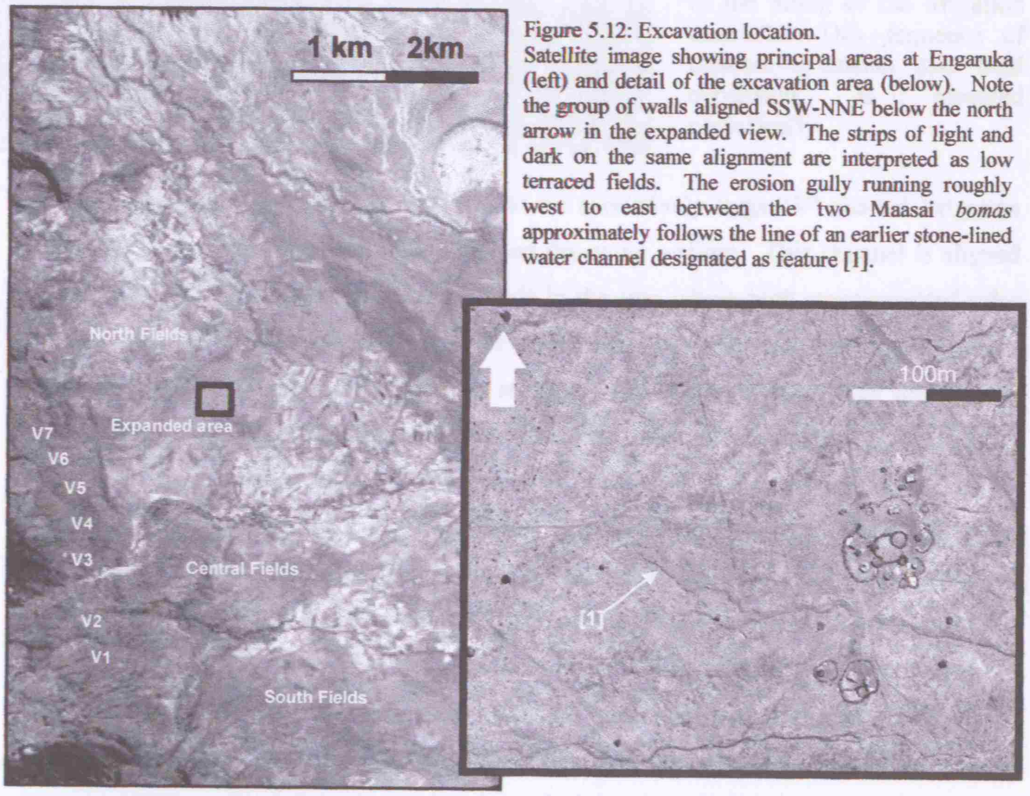


Figure 5.12: Excavation location.
Satellite image showing principal areas at Engaruka (left) and detail of the excavation area (below). Note the group of walls aligned SSW-NNE below the north arrow in the expanded view. The strips of light and dark on the same alignment are interpreted as low terraced fields. The erosion gully running roughly west to east between the two Maasai *bomas* approximately follows the line of an earlier stone-lined water channel designated as feature [1].

The excavation of six sections through feature [1] demonstrate that the structure was not built in a single phase of construction, but was instead periodically heightened and extended. Moreover, these episodes of extension are incorporated within a strategy of expanding the area of terraced fields, and are thus good evidence of the periodic inclusion of new areas within the cultivated landscape. In the first season, four phases of expansion were reliably attested to through stratigraphic evidence, whilst a further seven phases could be inferred from the patterning of fragments of field walls viewed in plan. An additional three phases relate to the original construction of feature [1], and indicate that this channel follows the line of a pre-existing, and probably natural, gully or stream. Subsequent work in 2003 refined this picture by demonstrating that large channels of this sort acted to deliver sediments onto the field area and also serve to supply water to smaller irrigation furrows.

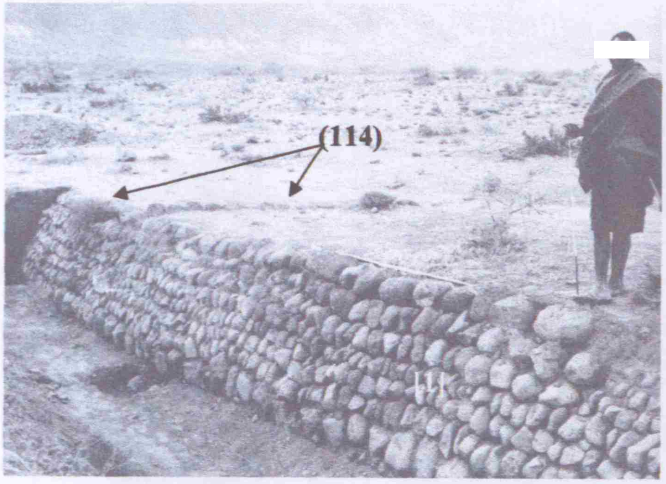


Figure 5.13:
Part of the northern revetting wall of feature [1] looking NW. Note the short segment of field wall (114) running NNE-SSW and joining [1]. (114) then turns to form part of the lining of the irrigation channel. This sequence of channel extension and field expansion is repeated periodically.

Prior to excavation, feature [1] appeared to be a relatively large 'V' shaped irrigation feature, lined on both sides by roughly coursed dry-stone walling. This channel is aligned running WNW to ESE and averages 1.3m wide in the area where both stone-revetted sides are preserved. Before work began the feature was visible for a length of approximately 60m, of which roughly 13m retained the southern revetting wall intact. A 1.5m wide section [10] was excavated through this feature at a point where both sides of revetting were apparently well preserved (see figure 5.14). The terminal fill (14) consisted of fine laminated olive-brown silty (loamy)-sand, and was 350mm deep. Fill (14) sealed a layer of small to medium sized rounded stones within a matrix of olive-brown silty-sand (12), which was interpreted as an alluvial fill, deposited as a consequence of the feature's water-carrying function. Removal of 370mm of this deposit revealed the base of the northern revetting wall (13), whilst the southern wall (11) continued. In the interests of preserving as much of the structure as possible, it was decided to excavate the remainder of this section out of sequence; (13) was thus left in situ, whilst the underlying deposit (9) was excavated a further 360mm, at which point the base of the southern retaining wall (11) was revealed. Deposit (9) was virtually indistinguishable from the overlying fill (12) in terms of colour, composition and texture, but was contexted separately as it pre-dates the insertion of the northern wall. The deposit stratigraphically below (11) is similar in composition to (9) and (12) though it contains larger stones, and was thus interpreted as a further alluvial layer, suggesting that [10] was constructed along the line of an earlier, possibly natural, watercourse. Excavation of this section was terminated at this point so as not to undermine the stone structures.

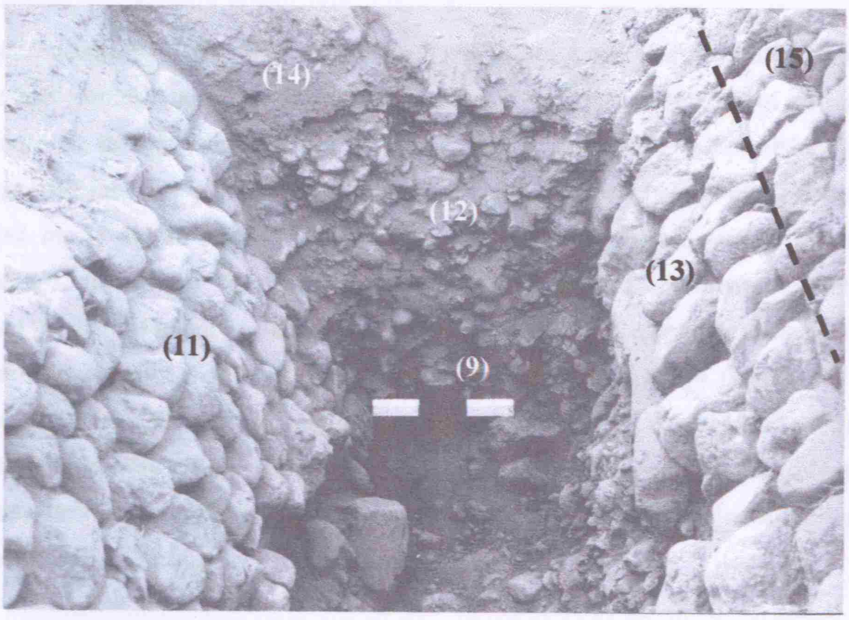


Figure 5.14:
East facing section through [10] with stone lining in situ. Scale = 300mm

The sequence presented by [10], therefore, is of an attempt to artificially augment a natural watercourse, initially by protecting its southern bank. The fact that the modern erosion gully [119] (see figure 5.15) that partially revealed the feature has itself eroded to the south, suggested that the southern wall was constructed as an anti-erosional measure, or, alternatively, that (11) was built to alter the course of the earlier channel. Subsequent work, however, demonstrates that the southern revetting wall forms part of an earlier phase of field construction. Nevertheless, after a period of use in which the primary fill (9) was deposited, the northern bank is also strengthened by the construction of (13). The continuation of the depositional process that produced (9) is attested to by (12), and is evidence that the feature remained in use following the construction of the northern wall. The excavation of subsequent sections through this feature suggested that the northern revetting wall evidenced here was built in two phases, the later of which was contexted as (15).

A further section excavated through [1] demonstrated a similar sequence of in-filling to that seen in [10]. This section was excavated approximately 38m to the ESE of [10] at a point where the southern wall is not preserved, and was undertaken primarily to expose a stretch of the northern revetting wall that had already been substantially revealed by erosion. The upper fill in this section (115) was again a deposit of fine laminated silty-sand, and was excavated to a depth of 0.58m. Deposit (115) produced no finds and was therefore interpreted as a post-abandonment deposit equivalent to (14). Below this layer was a deposit of light olive-brown laminate silty-sand with occasional small rounded stones (2), which itself sealed a light yellowish-brown silty-sand with common stone inclusions (3). Context

(2) produced only two pottery sherds, one of which has a grooved or double lipped rim. Oteyo (pers. comm.) notes that this form is absent from the assemblages collected by Siiriäinen et al., though it would appear to correspond most closely with Robertshaw's type 8 (a 'S' profiled jar with knotted-cord roulette decoration, Robertshaw 1986: 9 and 15, and illustrated on 13 figure 12); a form recovered by Sassoon from a terrace platform on 'Hillside 4'. In addition to six small fragments of bone and a cow tooth, context (3) contained 21 sherds including a horizontally incised rim sherd that appears to be an example of Robertshaw's type 11 or 11a (1986: 9 and 15 and illustrated on 14 figure 13); both of which are forms that were previously only recovered from stone circle C1. The retrieval of this pottery type from a field context thus calls into question Sassoon's and Robertshaw's earlier conclusion that the presence of unique ceramics from the stone circles indicates that these features date to a distinct period of Engaruka's history.

Deposits (2) and (3) both physically overlie the northern stone revetting structure (4) – see figure 5.15. The removal of (3) also revealed three courses of stone walling (123) that were interpreted as a remnant of the southern element of the ditch revetting wall. Stratigraphically, however, (3) overlies (124), a deposit very similar in composition and texture to the stony alluvial fills described above in reference to [10]. As in the previous section, the excavation of this deposit revealed the base of the northern wall, and is clearly the result of the same depositional process that also partially buried the southern wall. As in the previous section the alluvial material deposited prior to the construction of (4) was contexted separately and is referred to here as (122). The base of the northern wall at this point was recorded as at 934.3m above sea level (henceforth ASL), as compared to a level of 935.9 ASL in section [10]. This represents a fall of 1.6m over a horizontal distance of 38m or approximately 1:24. Excavation was arbitrarily halted at a depth of 1.4m below the contemporary ground surface with a view to carrying out a more complete excavation of the feature in an area less disturbed by recent erosion.

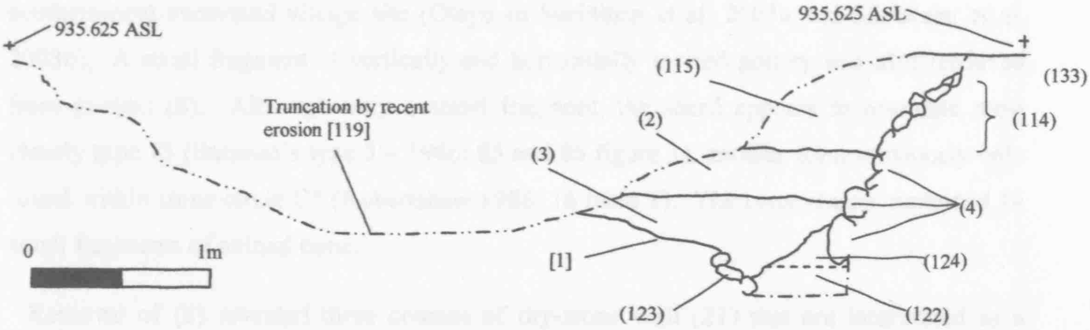


Figure 5.15: East facing section through feature [1]

The area chosen for this segment was located 4.6m to the NW of the section just described, at a point where a fragment of the northern revetment could be seen on the surface. Within the feature, the process of in-filling differs slightly to those seen in the two previously described sections (see figure 5.16). Here, the northern wall (6) is physically below a deep homogeneous olive-brown fine silty-sand (19) to a depth of 1.07m; revealing the base of the dry-stone structure at 934.952 ASL. Removal of (6) revealed that this had been built against a deposit very similar in colour, texture and composition to the layers interpreted as alluvial use-deposits in the previous sections. This material (7), however, contained a large fragment of unabraded pottery, which suggests it was not deposited as a consequence of water action. Deposit (7) was therefore interpreted as the redeposition of alluvial material removed from the base of the water channel and used as a foundation layer for the construction of the coursed stone revetment. This inference appears to be given added credence by the profile of the northern side of the feature prior to the construction phase, as revealed by the excavation of (7). This edge slopes at an angle of 110°, suggesting it had been undercut by erosion, thus prompting the construction of the revetting structure. The large undecorated body sherd retrieved from (7) was therefore probably deposited shortly before the construction of the northern wall.

A further layer of alluvial material was encountered physically and stratigraphically below (7). Contexted as (8), this layer is 2.6m wide, and extends 1.3m further north than the limit of the artificial water channel as delineated by the revetting wall (6). As such, the deposit was interpreted by the excavators as being further evidence that the feature functioned as a watercourse prior to the construction of (6), the insertion which reduced the width of the watercourse and reinforced its northern bank (Gitu and Pollard – archive). The deposit contained 24 fairly abraded pottery sherds, including a large fragment of undecorated long necked jar (Robertshaw's type 6 – 1986: 9 and 15 and illustrated on 14 figure 13), which is a form found within C1 and 'Hillsides 1, 2 and 3' (Robertshaw 1986: 16 table 3), though apparently not evidenced in the large assemblage collected by Siiriäinen et al. in the southernmost excavated village site (Oteyo in Siiriäinen et al. 2003a and Siiriäinen et al. 2003b). A small fragment of vertically and horizontally incised pottery was also retrieved from context (8). Although only a small fragment, the sherd appears to resemble most closely type 13 (Sassoon's type 3 – 1966: 85 and 86 figure 3), another form previously only found within stone circle C1 (Robertshaw 1986: 16 table 3). The context also contained 14 small fragments of animal bone.

Removal of (8) revealed three courses of dry-stone wall (21) that are interpreted as a surviving fragment of the earlier southern channel-revetting structure encountered in the previously described sections. Excavation was halted at this point for safety reasons, though it should be noted that the excavators considered that a further deposit of partially excavated alluvial material below (21) strongly suggests that the dry-stone revetments mirror the line of a pre-existing, and probably natural, watercourse (Gitu and Pollard – archive).

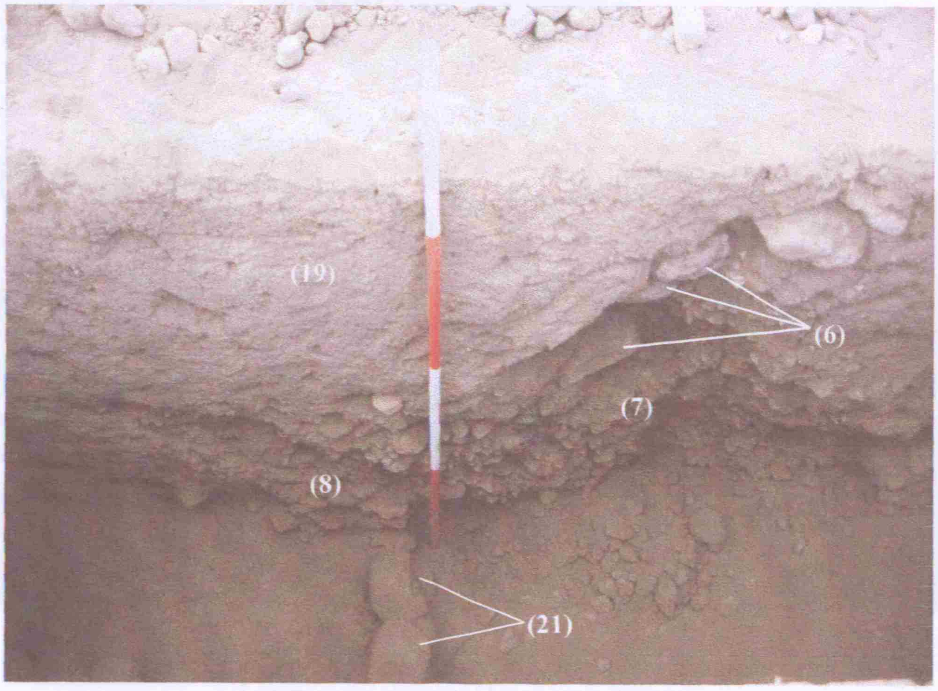


Figure 5.16: East facing section through [5]. Scale 2m

A further observation made by Pollard and Gitu relates to the possibility that the above section shows evidence of two phases of wall construction on the northern side. This observation prompted the re-examination of parts of the already well exposed elements of northern wall, and consisted of the excavation of three sections at locations where field walls intersect the northern revetting structure of furrow [1]. Investigations of a small irrigation furrow [42] and field wall (24) located approximately 17m to the north of [1] had suggested that the field walls themselves were likely to consist of one, or perhaps two courses, and indeed this preliminary conclusion concurs with those drawn by earlier examinations of the North and South fields (for example Sutton 1978: 44-45, though Sutton notes that agricultural terrace walls of up to six courses are evident on steeper ground). However, all three of the sections excavated to examine the relationships between field walls and feature [1] revealed that the stone alignments evident in plan were merely the upper courses of low terraces, the deepest of which (117) was roughly 0.7m in height. More importantly, these walls were all incorporated within construction episodes that included the maintenance of, and additions to, the large irrigation structure. Tracing these relationships made it possible to produce the phasing of furrow extension and field expansion summarised below. This expansion is most obvious in relation to wall/revetment (113).

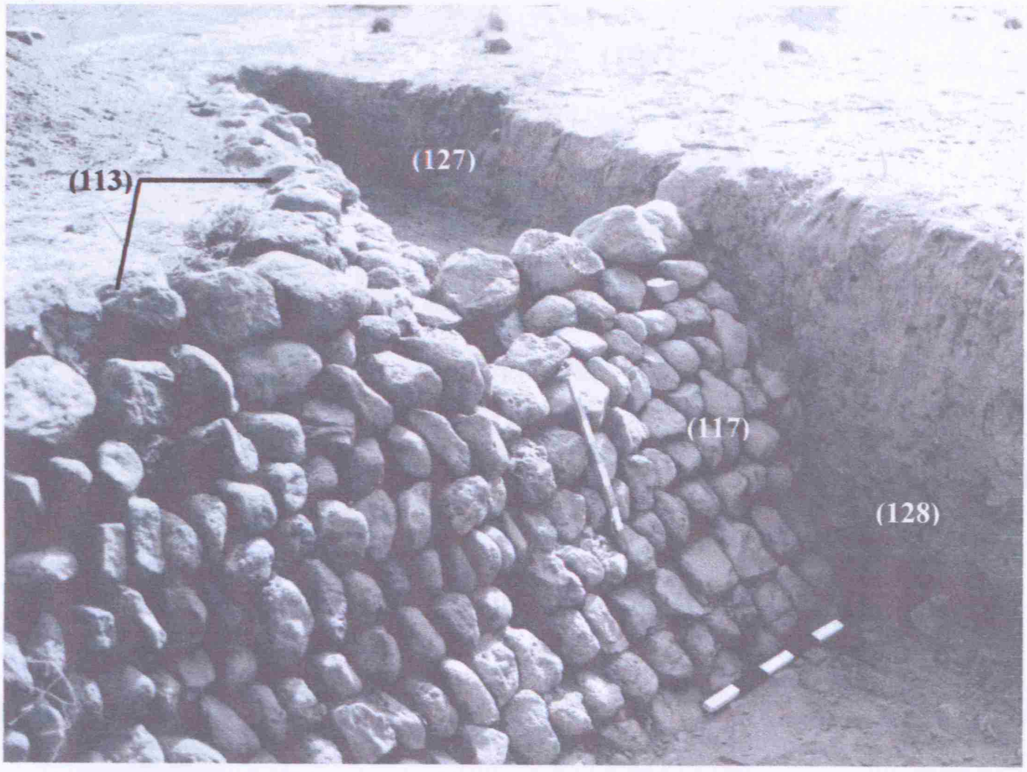


Figure 5.17: Oblique of west facing section across part of [1] showing wall (113).
Lower scale 500mm; Upper scale 400mm.

The section on the right of the frame in figure 5.17 is located 12.8m to the ESE of section [10] (see figure 5.26 for location) and was effectively cleared rather than excavated as the immediate area to the south of the wall had been badly affected by recent erosion and subsequent collapse. The section was extended, however, to remove some of the material upon which the upper courses of the wall nearest the section rests (127). It is clear that there are at least two phases to the construction of the wall at this junction, with the earlier element (113) forming both a constituent of the irrigation feature and also acting as the supporting structure for the down-slope boundary of an agricultural terrace. The dry-stone revetment (117) is thus a later addition. However, the removal of a small segment of (113) 7m to the northwest of the above section demonstrates that there are three phases of wall construction here, with the lowest three courses forming an earlier phase. Figures 5.18 and 5.19 demonstrate this relationship, with 5.18 showing the point of intersection between field wall/terrace (15) and part of the northern revetting structure for irrigation channel [1] following the removal of a fine silt topsoil layer (109). Wall (15) follows the same pattern of construction and use as described above in relation to (113) in that it acts as a revetment for both the water channel and a terraced field.

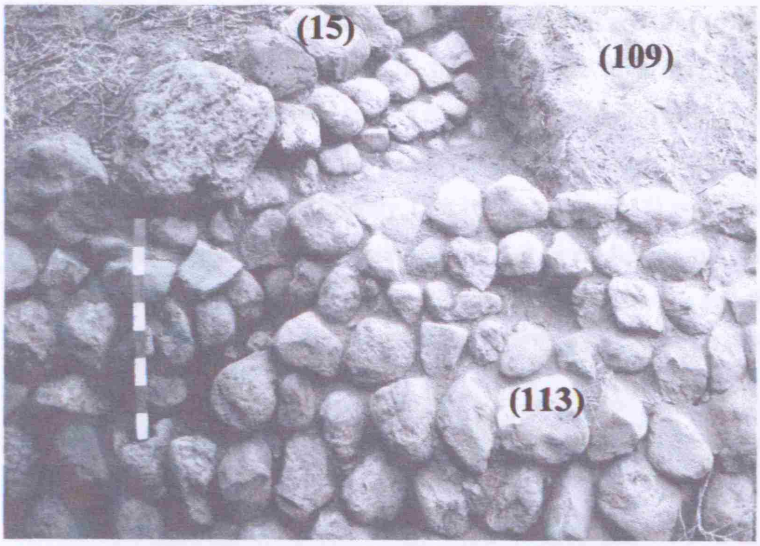


Figure 5.18

Detail of intersection between (15) and (113) looking north
Scale 400mm

Figure 5.19 shows the same area following the removal of part of (113). The base of (15) was encountered at 0.6m below the uppermost course, demonstrating that the three courses of large stones that form the base of the north side of the irrigation channel predate the construction of (15). Note that the dry-stone courses that form (113) are not self supporting and rely on the prior deposition of layers (111) and (110), both of which are banked against (15). Layer (109) is deposited following the construction of (113), though it is not clear at present whether this occurred post-abandonment or as a consequence of the use of the terrace system. The presence of surface finds throughout the field systems would, however, tend to argue for the latter. Nevertheless, in the period immediately following the construction of (113) there would have been a marked step at the point of intersection between these two terraces.

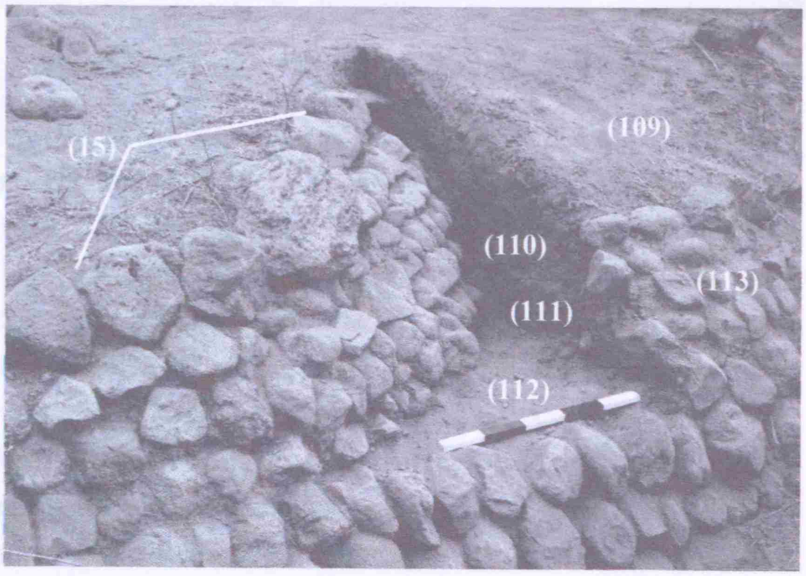


Figure 5.19

Detail of wall relationships (15) and (113) looking northeast
Scale 500mm

Having established the sequence of construction in relation to the terraces adjoining the large water channel [1] (at least in the immediate area of investigation), the combined channel extension and terrace walls (15) and (113) were traced in order to investigate their relationships to the terraced fields to the north. The point of intersection between these walls and a furrow located approximately 17m to the north of [1] was then examined. In the first instance, four sections were excavated through wall junctions, whilst a further two were excavated through the point of intersection between these walls and the furrow.

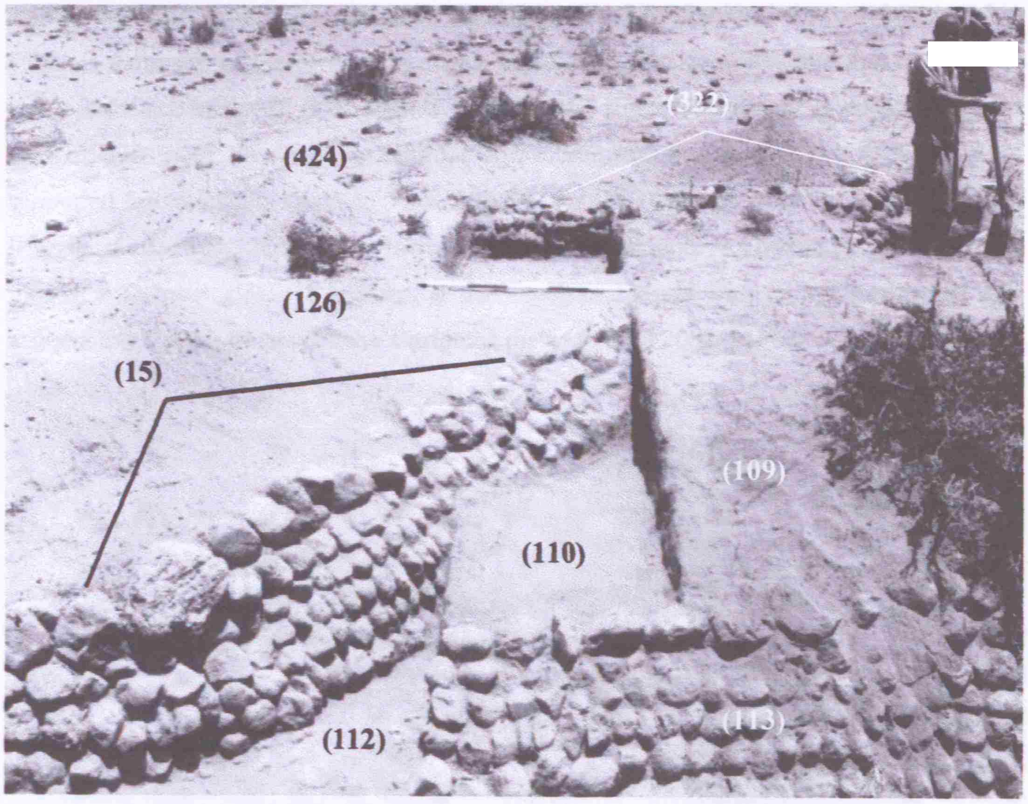


Figure 5.20: Channel [1] and associated terraces

Figure 5.20 shows the terrace and water channel junction (15)/(113) discussed above, with a further terrace wall (322) in the background. The layer upon which (15) rests, (126), is deposited above wall (322), demonstrating that the terraces to the north were constructed prior to those adjacent to the watercourse. The section under excavation in the above photograph shows that, as with the channel extension episodes described above, terrace wall (322) consists of an WNW-ESE aligned section which turns to the NE at an angle of approximately 120° to form two sides of a four-sided terrace (see also figure 5.21 below). The WNW-ESE aligned element of this containing wall is 6.9m long, whilst the SW-NE oriented segment measures 6.2m. Both elements are deeper in the down-slope SE corner where the wall is a five course structure, 0.53m in height. At its western limit this wall consists of just two courses measuring 208mm high, whilst at its northern terminus the structure is built in three courses totalling 251mm in height. This means that the layers that form the cultivation horizon within these terrace walls also act as levelling deposits. This effect is, however, fairly slight, converting a fall on the W-E axis of roughly 300m prior to the construction of the terrace, to an average fall of 70mm after construction. On the N-S axis the effect is slightly more pronounced (an average pre-construction fall of 290mm is converted to a post-deposition rise of between 10-30mm). Since this change of gradient would not offer any real advantage in terms of ease of cultivation it is probable that this effect is the result of the process by which these layers are deposited and that the desired result is the accumulation of sediments, although the slight lessening of gradient may have also offered more favourable conditions for subsequent irrigation. This latter view is supported by comments made by local farmers, several of whom observe that attempts to irrigate on even very slight slopes 'harms' the soil (for example Noah Madaha – comment in interview October 2003); a suggestion that receives support from a small group of soil samples taken from Mzee Madaha's irrigated maize field in 2003 (see below).

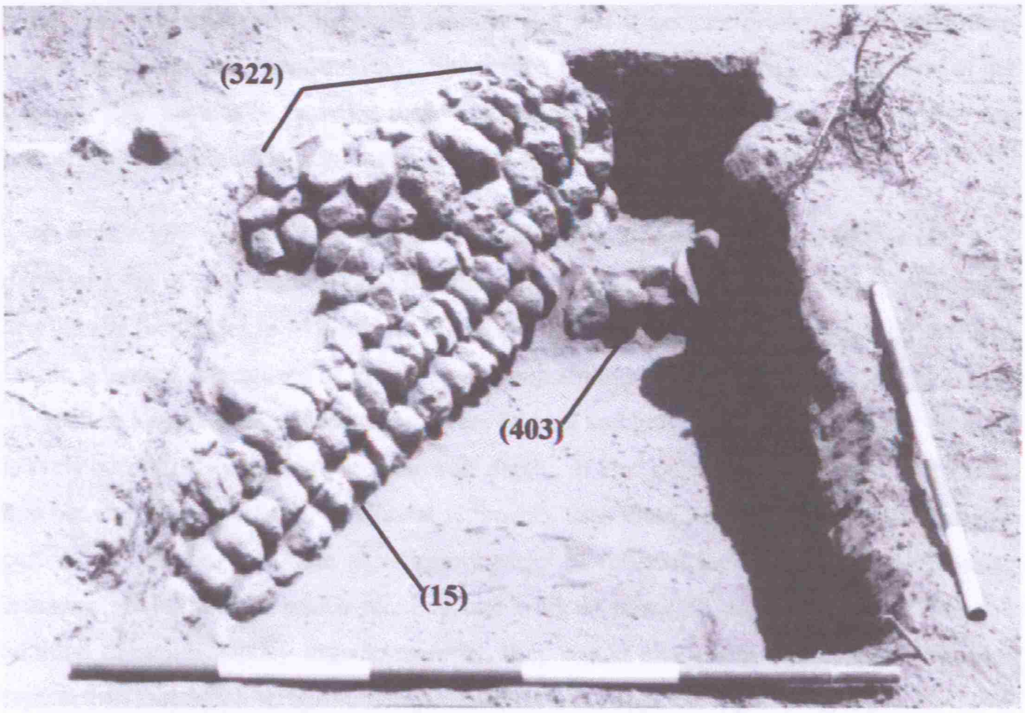


Figure 5.21: Terrace wall junction. Note that (322) pre-dates the construction of both (15) and (403). Once again, these walls are not self-supporting and thus require the prior deposition of the layers on which they rest. A further section excavated 5m to the ESE of the above junction demonstrates that, as with (15) and (322), (403) becomes a five-course structure in its SE corner.

Taking the dimensions of the terrace contained by (322) as an example, individual fields include upwards of eight cubic metres of fine silty-sand that were imported as part of the process of terrace construction. Given the sheer number of terraces in the North Fields area, it is inconceivable that this material was imported manually. Indeed, if it was manually imported, where was it imported from? The most feasible mechanism of deposition, therefore, is that these sediments were suspended within water carried by channel [1]. Certainly, the fact that the channel extensions/terrace walls are not perpendicular to the channel itself but are instead built at an angle of approximately 120° would seem to be indicative that these junctions are designed to act as water off-takes. However, the question remains as to whether this process of alluvial deposition was an intended consequence of the channel design, or whether it was an unavoidable by-product of irrigation. It is possible, for example, that irrigation channels such as [1] carried relatively fertile material off the escarpment in the wet season, and that this was incorporated into low terraces and farmed for a period of years whilst the next terrace was constructed from subsequently deposited material. Equally, however, it could be argued that alluvial sediments of limited fertility were deposited adjacent to irrigation features and that it became prudent to contain these within terraces (Adams pers. comm.). Either way, there is some indication in the form of the deposits that physically underlie these cultivation horizons that would suggest that the deposition of additional alluvial material offers some agricultural advantage.

An exploratory sondage (see figure 5.26) excavated through the centre of a terrace to a depth of 1.4m in 2002 demonstrates that this terrace seals a sequence of layers of silty-sands and gravels (contexted as 31 and 54-67). Below the uppermost layer of silty-sand contained within a terrace, a sequence of gravel layers predominate to a depth of nearly half a metre. Thereafter, a succession of alternating layers of sand and gravels were encountered, with the gravels becoming increasingly coarse with depth. If this sequence is typical of the layers that pre-date the importation of alluvial sediments, then these later deposits would represent cultivation horizons that were significantly easier to till; that had slightly improved water retention properties; and which required less work in terms of stone clearance. With the addition of supplementary organic material, they would also act as a substantially deeper topsoil than that which had presumably existed over the uppermost gravel layers.

One aspect of this schema that would require additional data to resolve, is the question of whether the process of levelling the terraces would have necessitated manual intervention. That is to say, it is not clear whether alluvial sediments were captured within individual field-sized barrages, or whether these were deposited over a far larger area and were then physically dragged back to form a field of the desired depth, before being enclosed within a dry-stone wall. An examination of the micro-sedimentology of the cultivation horizons might resolve this issue, though of course subsequent tillage and the amalgamation of additional organic material is likely to have substantially disturbed characteristic alluvial laminations (MacPhail pers. comm.).

Nevertheless, the excavation of three further wall intersections all demonstrated the same sequence of construction and sediment deposition as evidenced in the (15)/(322)/(403) junction. However, in the other excavated areas the point of intersection between the latest wall and the two earlier terrace structures was disturbed, and in one instance was so damaged that the walls no longer met. Examination of the two furrow sections to the north suggests that this damage is a consequence of irrigation water being channelled across these walls, eroding away the sediments on which the structures sit (see figure 5.22 below).

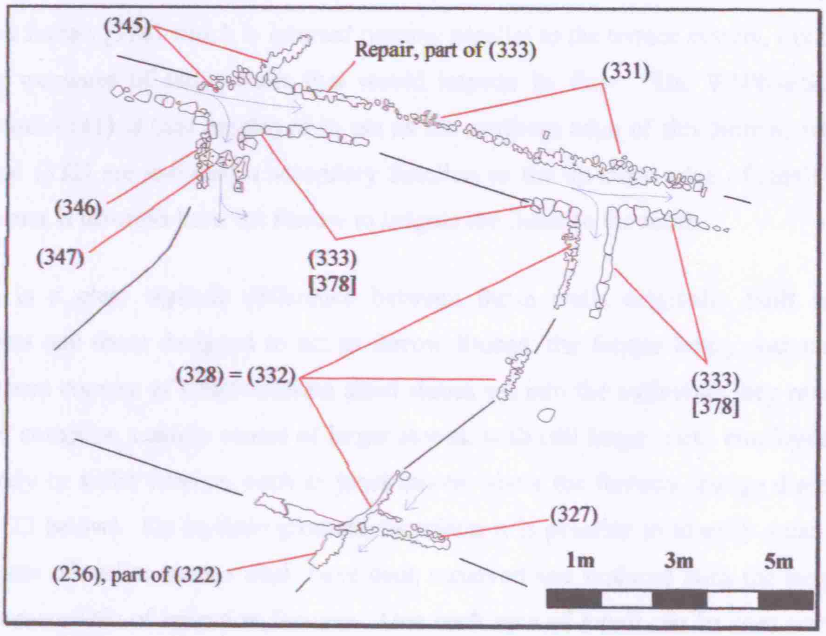


Figure 5.22: Plan showing furrow junctions and terrace intersection (322)/(332)/(327). Annotation in red; projected lines of features in black; direction of water flow in blue. Note damage caused to (327) by flow of irrigation water.

As noted above, the furrow is located approximately 17-18m (i.e. three fields) to the north of the large water channel and runs broadly parallel to it. It is, however, a far smaller feature, measuring on average 500mm wide and is rarely more than 100mm deep. In the section investigated in 2002 [42] it was lined on both sides by single courses of medium-large (i.e. > 100mm) stones, and was extremely indistinct where the lining was absent. The base of the feature is unlined, though a shallow deposit of sand and grit was frequently encountered at the level of the base of the stone lining and was taken to represent the bottom of the feature. Although [42] was first excavated at a point where it met a field wall on its north side, since both features merely consisted of single-coursed stone lines, it was not possible to discern accurately their relative chronological relationship. The two sections explored in 2003, in contrast, were both excavated at points where this feature intersected with multiple-coursed field walls, and indeed were found to consist in part of earlier terrace walls that had subsequently been re-employed to act as furrow linings.

The southernmost feature depicted in figure 5.22 is the northern terminus of terrace wall (322), the stratigraphic context of which was outlined above in relation to the main water channel. This wall post-dates an earlier terrace wall of the same style and form; contexted in its various excavated segments as (338), (325), (328) and (332). This in turn post-dates the wall that forms the western side of this terrace (346), and the wall that forms its northern side (331). Parts of all three of the walls that form this terrace are later re-used as elements of the irrigation furrow [378] which is inserted running parallel to the terrace system, truncating the northern extremes of those walls that would impede its flow. The WNW-ESE aligned terrace wall (331) is thus employed to act as the northern edge of this furrow, whilst both (346) and (332) are assigned a secondary function as the up-slope edge of small off-takes where water is diverted from the furrow to irrigate the fields to the south.

There is a clear stylistic difference between those walls originally built as terrace revetments and those designed to act as furrow linings: the former being characterised by two or more courses of small-medium sized stones set into the sediments they revet, whilst the latter comprise a single course of larger stones, with still larger rocks employed in areas most likely to suffer erosion, such as junctions or where the furrows change direction (see figure 5.23 below). On stylistic grounds, therefore, it is possible to identify areas of repair where parts of earlier terrace walls have been removed and replaced with the larger stones more characteristic of irrigation features. One such area of repair can be seen on the north side of the western furrow junction in figure 5.22 above. This junction also includes a pair of stones (347) set within, and stepped back from, the off-take. A similar set of stones were removed during the excavation of the junction to the east since they were not built into the fabric of the furrow-lining and rested upon the fine grit layer in the base of the feature. This observation (far clearer in furrow junction [385]/[390] discussed below) suggests that these stones are a design element that can be removed or replaced as required. Their exact function is unclear, but based on their position it seems most likely that they act as a base upon which trash can be piled to temporarily close a channel. Having observed these blocking stones in the excavated sections, subsequent walkovers throughout the North, Central and South Fields demonstrate that these are common features within furrows and can thus be used to locate junctions and off-takes.

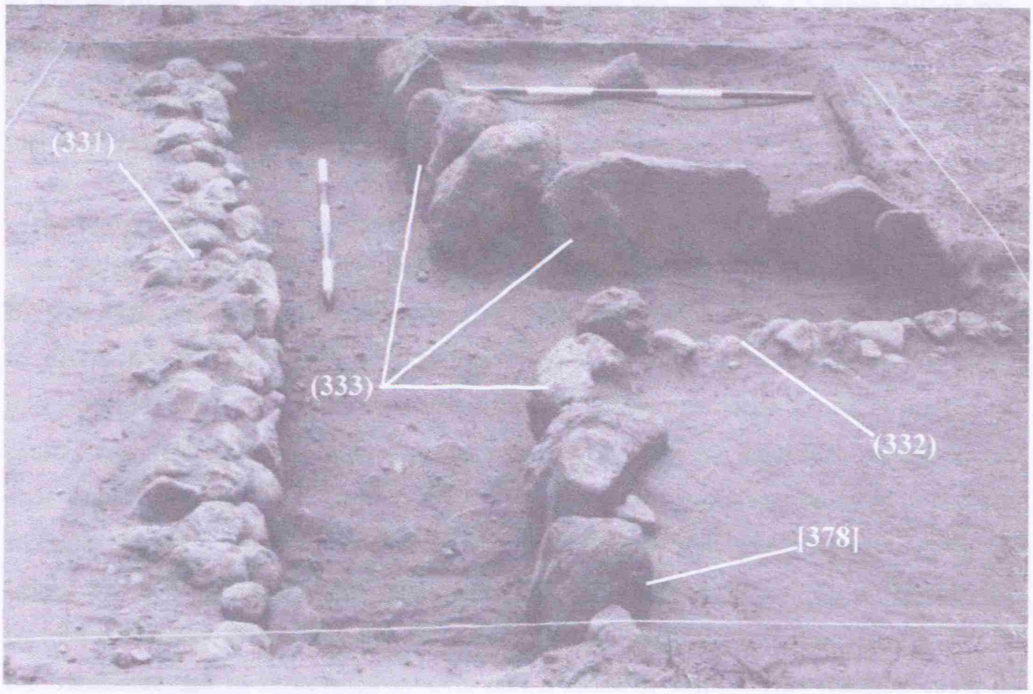


Figure 5.23: Furrow junction showing stylistic differences in wall construction, looking E. Note the large stones set on their sides at the point of off-take. Scales 2 x 1m.

Through the above outlined excavated segments it is possible to establish a detailed stratigraphic sequence of the construction of the main water channel [1] along with six associated agricultural terraces and an irrigation furrow [42]/[378]. Although this demonstrates that the irrigation furrow was the latest addition in this relative chronological sequence, the lack of absolute dates for construction means that the time lapse between establishing the fields and the subsequent insertion of [42]/[378] is not known. This is potentially extremely pertinent in terms of modelling the operation of the field system, as a relatively late construction date for the furrow might suggest that a change in conditions forced the community to create a method of delivering more water to the agricultural plots. A change in the local climate, particularly in terms of rainfall, or an intensification of production, perhaps prompted by increased population or soil depletion, might all conceivably lead to a need for the creation of additional irrigation features. It was therefore necessary to question whether this feature was an original element of the field system design. For this reason a further section was excavated through the furrow with the aim of identifying the source of the irrigation water (had a decline in the flow of [1] forced importation from a more reliable source?) and to establish whether this furrow truncates elements of the pre-established layout of fields (thus demonstrating that the feature represents a modification and that its necessity had not been anticipated). Attempts to trace the line of this feature in plan had already shown that the furrow could not continue up-slope to the WNW without crossing or truncating field walls and, as such, a further section was excavated at the projected point of intersection between the furrow and one such terrace wall. However, there are indications in the evidence already outlined above that could imply that the furrow's insertion was planned during the field construction phase.

The first suggestion is in the shape of the terrace walls (346) and (332) that are re-used to form the sides to the furrow off-takes where they deliver water onto the agricultural plots. Both of these walls curve; gradually changing alignment from the N-S orientation necessary to divert water from the furrow, to the NE-SW bearing characteristic of the other investigated terraces. If this curve was itself a later amendment made as part of the furrow construction episode, one would expect the coursing to reflect the large stone, single course style employed elsewhere in furrow design. The second indication that the need to create a secondary irrigation feature was anticipated is based on the size, and more particularly the height, of the water channel extension walls. With height increases of up to 0.6m in the excavated sections, direct irrigation of recently completed fields would require the area to the immediate east to be covered by over half a metre of water. This situation could of course be avoided by damming the watercourse adjacent to the heightened fields. However, given that the surface heights of neighbouring terraces demonstrate an average incremental fall from west to east of 200mm, it is clear that the damming strategy would require the constant dismantling and replacing of dams in order to irrigate groups of fields as little as ten metres apart.

Nevertheless, in order to refute or corroborate the impression formed from these terrace alignments and channel heights, a section was excavated 13m to the WNW of the westernmost furrow section described above. This section demonstrates that at this juncture the furrow behaves in a way that is entirely consistent with the construction strategy already defined. Rather than truncate the field walls that would block its course to the WNW (350 and 410), the furrow turns to the SE, utilising these walls to form its west bank (see figure 5.24). Tracing this new course in plan indicates that the furrow is fed from an up-stream off-take from water channel [1]. Moreover, at the point where the furrow changes alignment a smaller furrow [414], with associated internal damming stones as seen in other off-takes, continues to the NE. Tracing this smaller furrow in plan and taking levels along its course demonstrates that this feature drains south, into [378]. Although this information was initially taken as evidence that some additional irrigation water was being imported into [378] from a secondary source, the broader EDM survey, together with the excavation of other furrow junctions, would suggest that the water within [414] was probably drawn from a further off-take from channel [1] (see below).

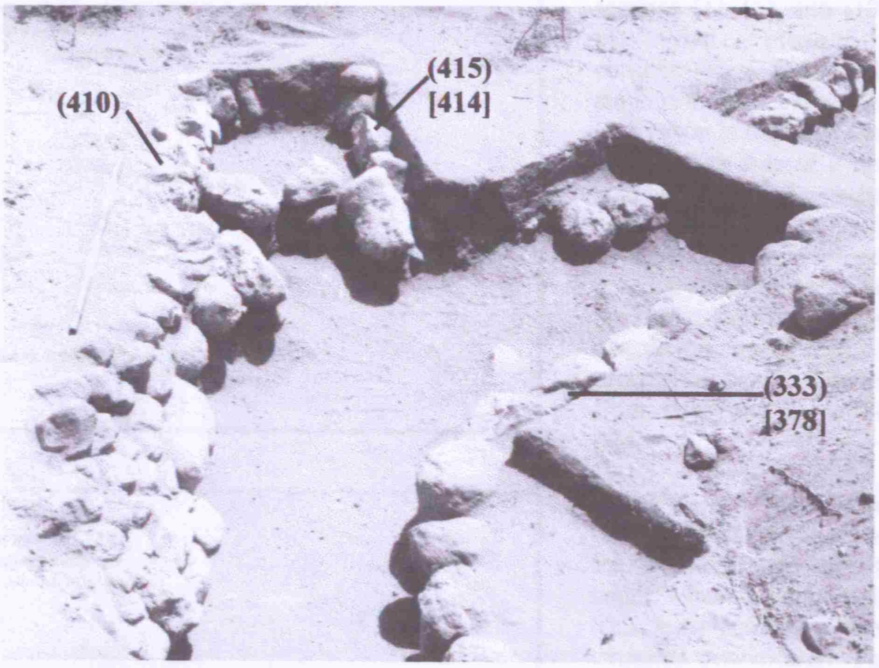
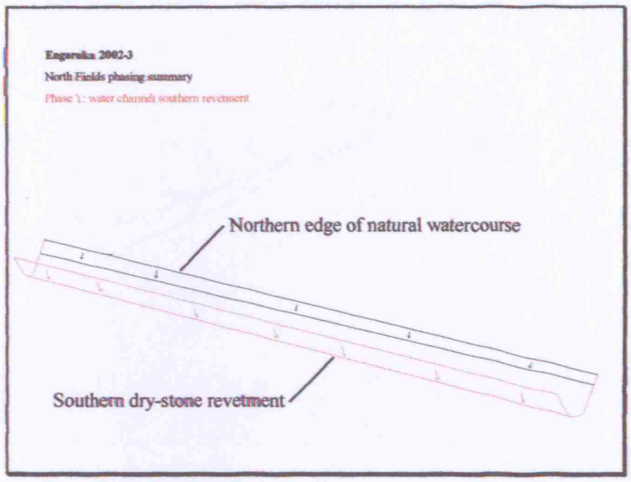


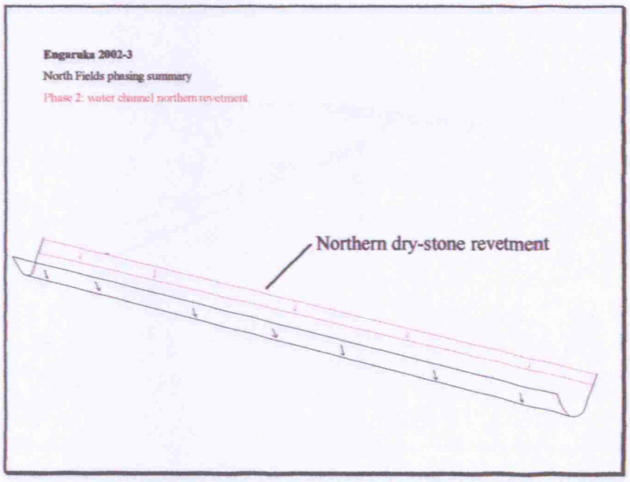
Figure 5.24: Furrow junction [378]/[414] looking NNE. Scale 1m

In the opinion of the excavator (Ellerby - archive), the smaller south-flowing furrow [414] was the first to be constructed and that, following the creation of the terrace group and its attendant furrow described above, this earlier feature was rendered redundant and was thus allowed to go out of use. Supporting evidence for this hypothesis comes in the form of the broader chronology of terrace construction that will be outlined below, as well as from a difference in the textures and consistencies of the fills of the two furrows: the fill of [414] being coarser and containing more stones, suggesting it was not deposited by water flowing within the feature. Unfortunately, since the boundary between these two fills is formed by the damming stones, and because the insertion of [378] would have removed any evidence of the former limits of the earlier cut, this interpretation cannot be proved stratigraphically. Based on the layout of all the mapped irrigation features in this area, the view preferred here is that the system was designed to be as flexible as possible and that, moreover, the furrows are designed to filter any water not used for irrigation into another channel (as is the case in North Pare – Sheridan 2002: 87). As such the interpretation offered here is that, although [414] may indeed pre-date [378], both furrows were probably in use concurrently.

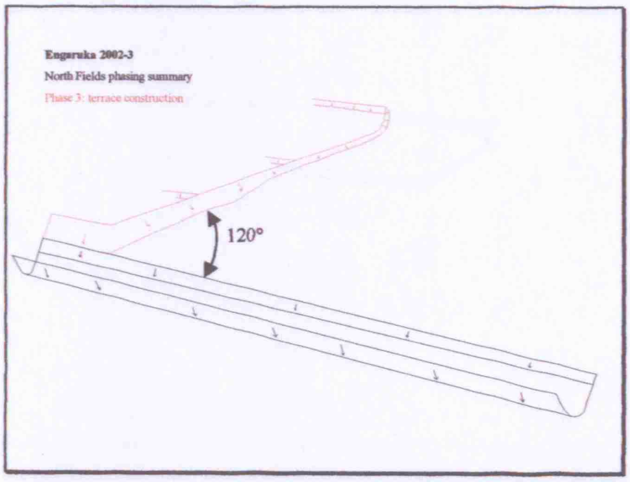
By way of summary, the sequence of construction of the features in the main excavation area is depicted in the following schematic (figure 5.25).



Phase 1: As evidenced in sections [1], [5], and [10], the first phase of construction undertaken in the principal area of excavation is the revetment of the south side of a pre-existing, natural water course. This is undoubtedly a staged process, although the physical length of the constituent stages can, at present, only be inferred from field lengths to the north.

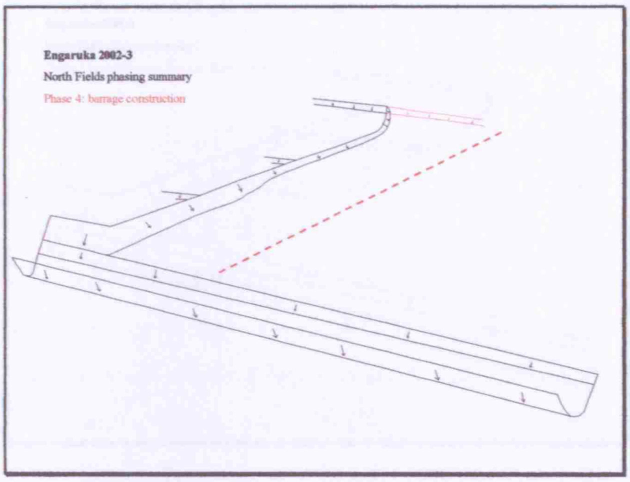


Phase 2: The lower courses of the revetment on the northern side of the water channel are built. This too would have been extended periodically. The height to which they are built indicates minimum water level if this feature is to deliver water onto the fields to the north. Note, however, that this may be minimum water level of the feature in full spate.

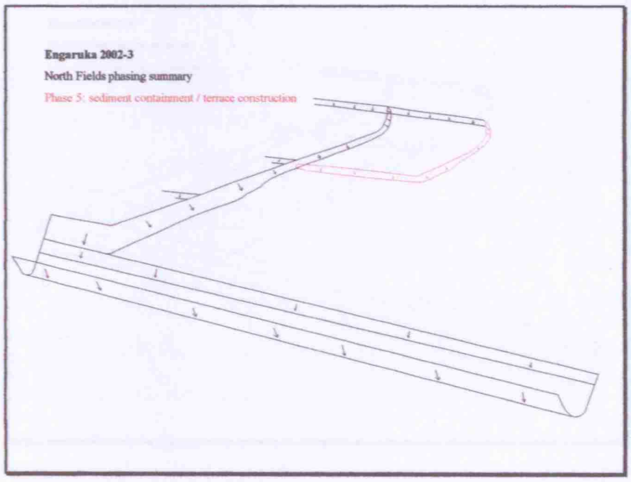


Phase 3: The terraces to the west of those described above are built. The process of construction is outlined in phases 4 – 7 below. Note that all of the broadly N-S aligned walls are not perpendicular to the water course, and are instead oriented at an angle of approximately 120°. This is a functional design element related to diverting water from the channel.

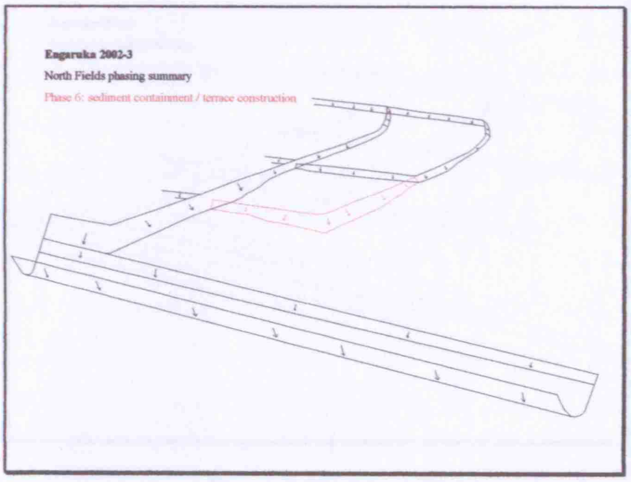
Figure 5.25: North Fields excavation phasing summary
(continued below)



Phase 4: A barrage is constructed to capture water and sediments carried within the water channel. This process may have also necessitated the temporary damming of the water course below the barrage. The northern extent of this barrage is formed by a structure that is subsequently used as a terrace wall. The fact that the down-slope containing terrace walls post-date the sediments they revet demonstrates that the barrage was a temporary structure; perhaps a simple mound of earth or trash. For illustrative purposes the barrage is shown here as being one field wide, though it may have been built to cover a larger area, with the sediments then hoed back to form a terrace.

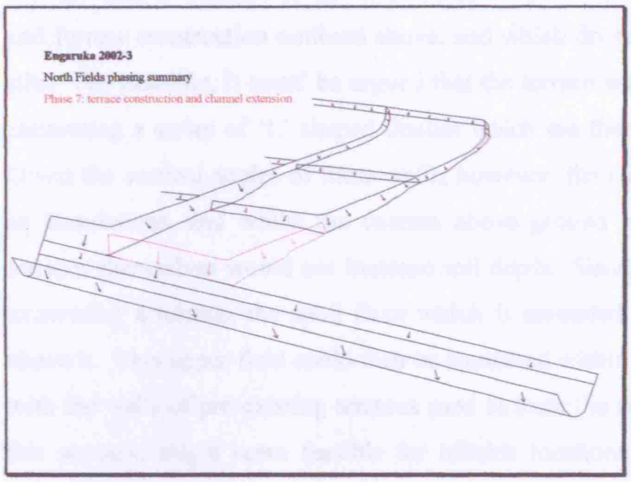


Phase 5: Sediments captured behind the barrage are deposited within the new field, partially burying the barrage wall to the north. These are either cut to insert a containing terrace wall, or physically dragged back to form a field and then enclosed.

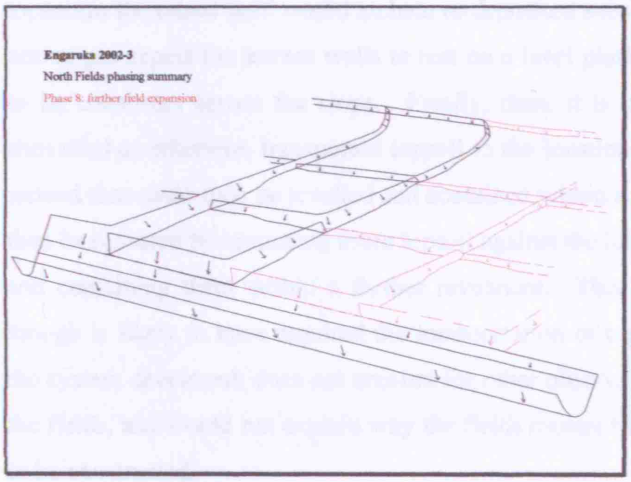


Phase 6: Alluvial sediments are deposited against the terrace wall constructed in the preceding phase, and are contained within a further terrace wall. The deposition of this material levels the topography reflected by the base of the walls.

Figure 5.25: North Fields excavation phasing summary
(continued below)



Phase 7: A further field is constructed in the same manner as described above. However, here the construction of the terrace heightens the northern side of the water channel. It is probable that water can no longer be applied to these fields directly without physically lifting it in some way.



Phases 8 and 9: Either a series of further fields are constructed which are then irrigated by the insertion of a furrow as depicted here, or else the furrow is constructed and extended as each new set of fields are built. The irrigation furrow is necessary to supply water to fields that are now above the level irrigable directly from the main watercourse. Water for this furrow is drawn from an up-stream off-take of the same water course that was employed to create these fields. These two observations, when coupled with the fact that the terrace walls that are re-used as elements of this furrow appear pre-designed for the purpose, strongly suggests that the insertion of the furrow was part of the original field system design and does not reflect a change in conditions or a response to stress.

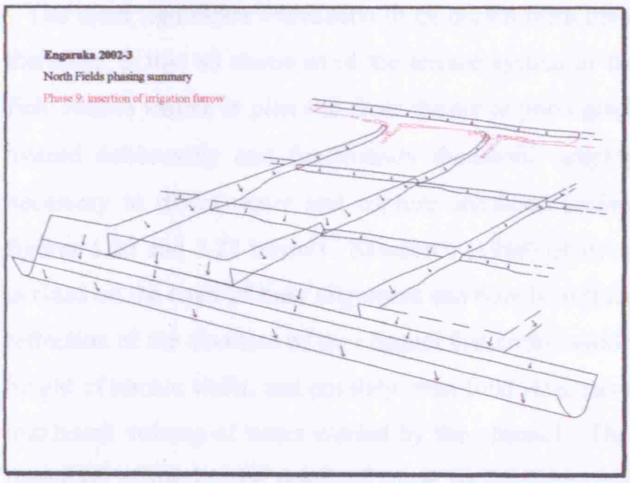


Figure 5.25: North Fields excavation phasing summary

There are, however, alternative scenarios that fit with the stratigraphic sequence of field and furrow construction outlined above, and which do not require the deposition of alluvial silts. For example, it could be argued that the terrace walls are within cut features, built by excavating a series of 'L' shaped ditches which are then revetted and partially back-filled. Given the vertical angles of these walls, however, the sub-surface elements could not serve as foundations, and whilst the courses above ground would help to level the fields, the terraces themselves would not increase soil depth. Similarly, the fields could be formed by excavating a terrace, the spoil from which is mounded to increase the height of the field above it. This upper field could then be contained within an 'L' shaped dry-stone revetment, with the walls of pre-existing terraces used to form the other two sides. However, although this scenario might seem feasible for hillside locations it would appear ill-suited for the relatively flat ground of the North Fields at Engaruka, and would not increase the depth of topsoil as the raised field would include re-deposited subsoil. Moreover, if this were the case one might expect the terrace walls to rest on a level platform and for the number of courses to be consistent across the slope. Finally, then, it is possible that farmers simply hoed, shovelled or otherwise transported topsoil to the location of the proposed terrace, forming a mound that could then be levelled and contained within a dry-stone wall. This process could then be repeated by mounding more topsoil against the lower courses of one side of this wall, and containing them within a further revetment. This last scenario is perfectly feasible, though is likely to have required the transportation of topsoil over ever greater distances as the system developed; does not account for other observations such as the shape and form of the fields, and would not explain why the fields closest to the watercourses were not the first to be constructed.

The most significant conclusion to be drawn from the schema summarised in figure 5.25, therefore, is that all elements of the terrace system in the North Fields are functional. The field shapes visible in plan and from the aerial photographs are not 'roughly square', but are instead deliberately and functionally rhomboid; employing the characteristic 120° angle necessary to divert water and capture entrained sediments from the main channels (see figures 5.26 and 5.27 below). Sassoon's (1966) observation that groups of terraces can be defined on the basis of their alignment can now be refined, since field orientation is simply a reflection of the direction of the channel that contributed to their construction. Similarly, the height of terrace walls, and possibly even field size, can now be viewed as an artefact of the maximum volume of water carried by the channel. The size and form of the fields is not, therefore, primarily the result of some social factor such as a system of inheritance or a reflection of group ownership (such factors could easily be accommodated within a cognitive, rather than physical, landscape): they are the result of the technique of construction. Consequently, the time frame in which these fields are constructed must have been at least partially constrained by rates of sediment deposition. There is thus no evidence that the operating community felt pressured to expand the area under cultivation as quickly as possible.

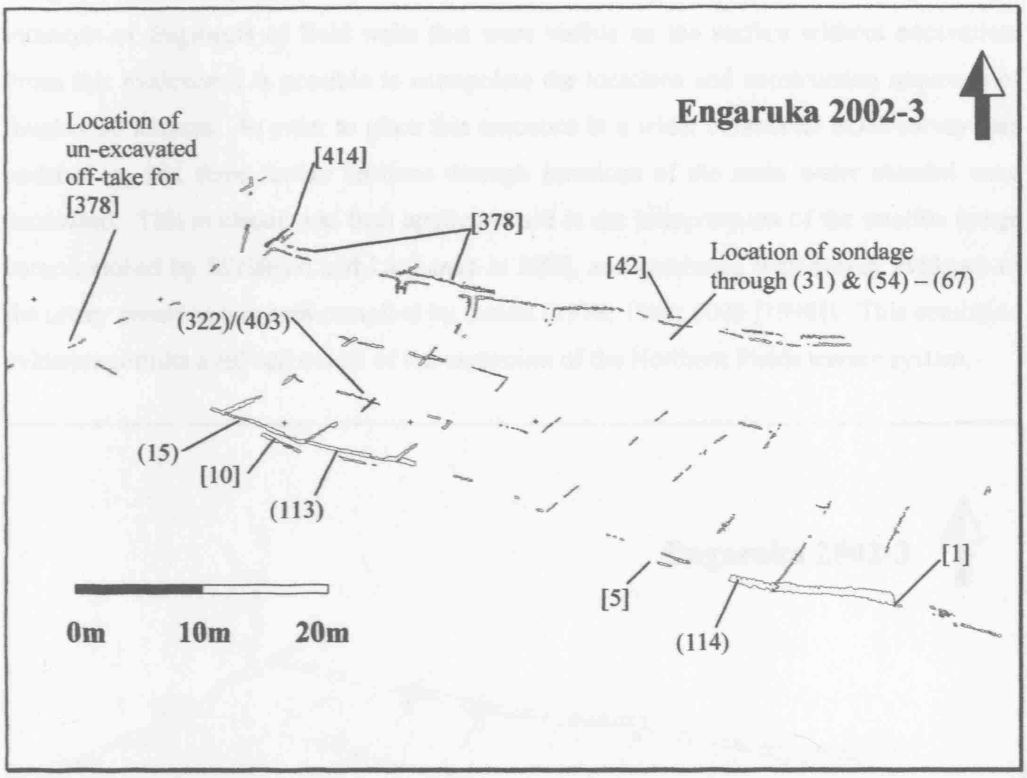


Figure 5.26: Plan showing principal contexts mentioned in the text.

Integral to this schema, then, is the role of the main channel [1], a large stone-lined ditch that acted to deliver water into dedicated irrigation furrows such as [42]/[378], but which appears to have also served to deliver sediments onto the cultivation area, thus increasing the depth of the topsoil and permitting the construction of level terraced fields. Moreover, investigation of this feature offers important insights into the nature of the landscape and environment prior to the construction of the terraces. Evidence from the excavated sections through [1] strongly suggests that the channel was not placed artificially within the landscape, but instead represents a relatively subtle modification of a pre-existing natural watercourse. Similarly, it is probable that the construction of the terraces exploits a further pre-existing phenomenon in the form of sediments carried within these watercourses. Perhaps more importantly, the excavation and recording of features of this type provide the evidence necessary for any attempt to model the former hydrology of the irrigation system at Engaruka. However, at approximately 3000m², the area shown in figures 5.26 and 5.27 represents a mere 0.3% of the total area of the North Fields identified thus far. It is therefore necessary to examine whether the features described above are representative of the area as a whole.

The excavation area and its immediate environs

Figure 5.27 below shows the features described in the preceding section along with the locations of fragments of field walls that were visible on the surface without excavation. From this evidence it is possible to extrapolate the locations and construction sequence of roughly 30 terraces. In order to place this sequence in a wider context an EDM survey was undertaken, and three further sections through junctions of the main water channel were excavated. This evidence was then applied to aid in the interpretation of the satellite image commissioned by Siiriäinen and Laulumaa in 2002, and combined with survey evidence of the artery canals in this area compiled by Sutton (1978; 1984; 2000 [1998]). This combined evidence permits a refined model of the expansion of the Northern Fields terrace system.

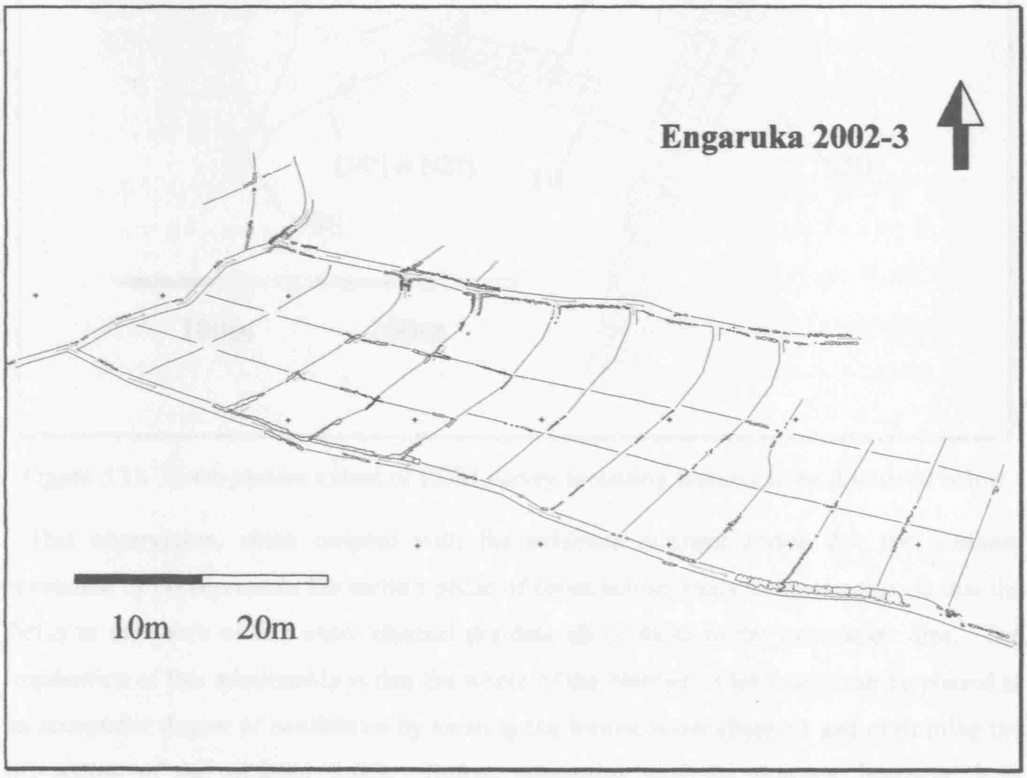


Figure 5.27: Extrapolated plan of fields in excavation area

The principal area to be discussed here is the north-eastern extent of the EDM survey and is depicted in figure 5.28. The excavation area outlined above is in the centre of the frame. The most obvious observation to be made regarding this plot is that the broadly SW-NE orientation of field walls as evidenced through excavation is reproduced throughout this area, demonstrating the likelihood that the construction methods defined above are also repeated.

Note, however, the orientation of the group of fields in the south-east. If these were built utilising sediments drawn from channel [1], then one would expect them to appear as a mirror image of the fields defined via excavation, as the characteristic 120° off-take angle would put these fields on a NW-SE bearing. The repetition of the SW-NE alignment suggests, therefore, that their construction employed sediments captured from a further water channel located to the south.

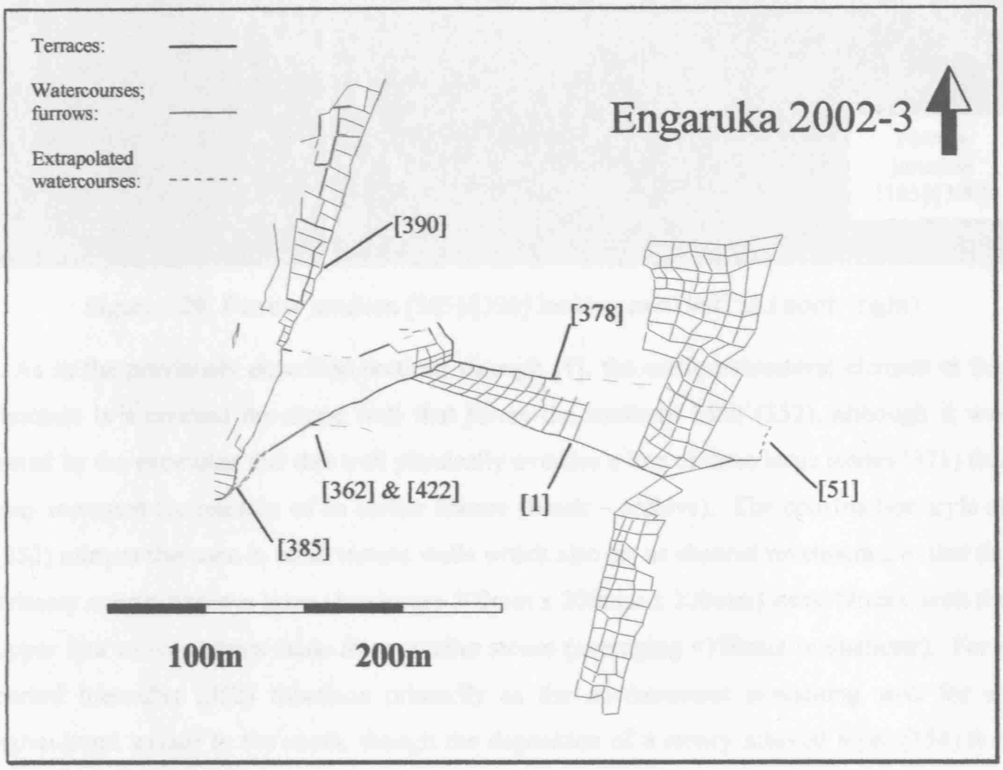


Figure 5.28 North-eastern extent of EDM survey including features to be discussed below

This observation, when coupled with the evidence outlined above that the southern revetment of [1] represents the earliest phase of construction, leads to the conclusion that the fields to the south of this water channel pre-date all of those in the excavation area. The implication of this relationship is that the whole of the Northern Fields area can be phased at an acceptable degree of confidence by locating the former water channels and examining the orientation of the adjacent fields. Before attempting such an analysis, however, it is necessary to confirm this relationship by outlining the results of three sections excavated through junctions in water channel [1]. These contribute evidence to this broader phasing schema as well as supplying information of relevance to the system of water management employed.

The westernmost, and stratigraphically earliest, section to be excavated was a junction between the water channel [contexted here as 385] and a SW-NE aligned furrow [390].

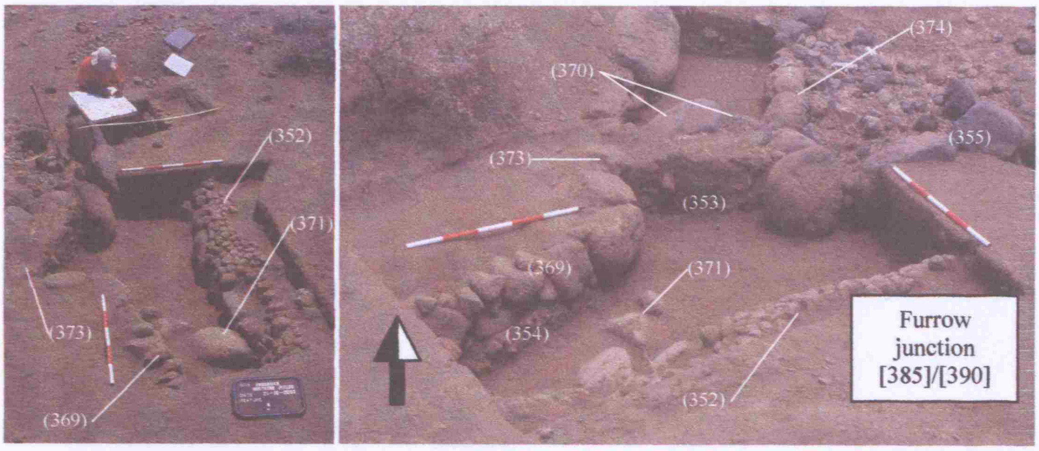


Figure 5.29: Furrow junction [385]/[390] looking east (left) and north (right)

As in the previously described sections through [1], the earliest structural element at this juncture is a coursed dry-stone wall that forms the southern bank (352), although it was noted by the excavator that this wall physically overlies a line of three large stones (371) that may represent the remains of an earlier feature (Black – archive). The construction style of (352) mirrors that seen in other terrace walls which also act as channel revetments, in that the primary course employs large (maximum 500mm x 200mm x 200mm) stone blocks, with the upper four to six courses made from smaller stones (averaging <150mm in diameter). For a period thereafter (352) functions primarily as the northernmost containing wall for an agricultural terrace to the south, though the deposition of a stoney alluvial layer (354) that partially seals this wall on its northern side indicates that water is still allowed to flow within the stream. In keeping with the sequence of construction evident in the previously described sections through [1], the deposition of alluvial material in the base of the channel is followed by the construction of a wall that forms the northern side of the water channel (369) and which then turns at an angle of roughly 120° to form the eastern containing wall of a terrace (here contexted separately as 373). Although there is some ambiguity in the exact sequence of construction owing to later truncation, the surviving segment of a SW-NE aligned wall (355) that is partially sealed by a further deposit of alluvial material (451) suggests that, as one would expect from the results within the main excavation area, a further terrace is later constructed and is contained by a dry-stone wall which also acts to protect the northern side of the channel. Unlike in the previously excavated sections that include channel extension episodes however, wall (369)/(373) is subsequently re-employed to form the west side of a furrow [390], and thus serves to offer an indication of what the un-excavated off-take for furrow [378] may look like. Interesting, the damming stones in this furrow are inserted after the construction of the feature, as is evidenced by the prior deposition of a layer of alluvial stones and grit (353). The sequence of construction, therefore, is as follows:

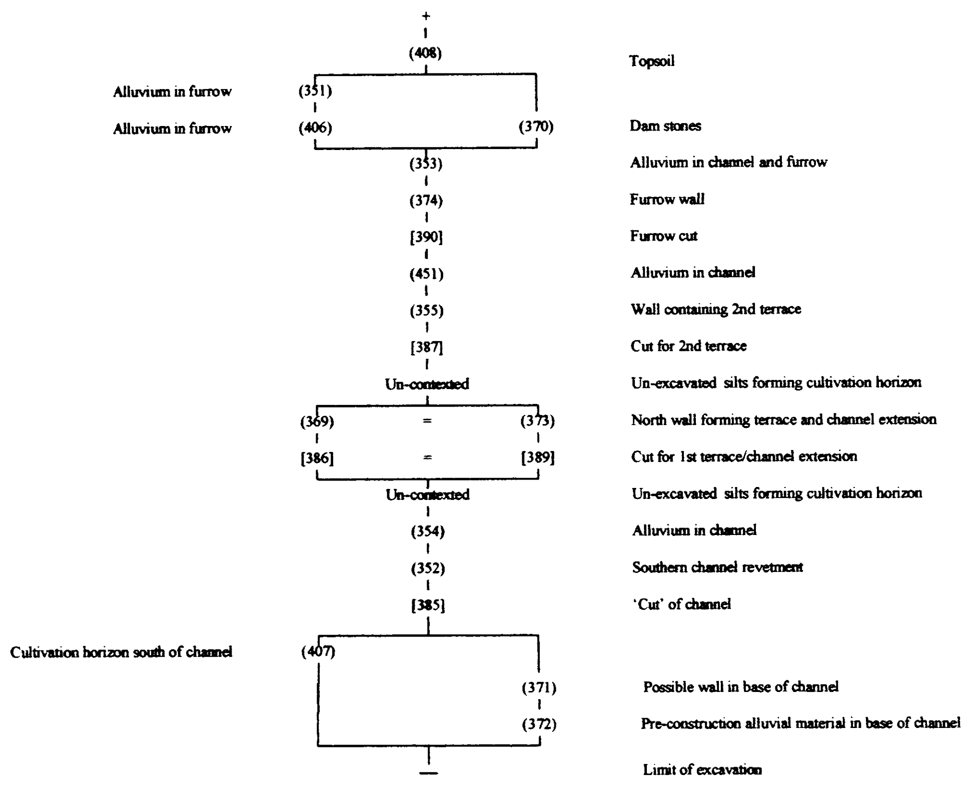


Figure 5.30: Stratigraphic matrix of furrow junction [385]/[390]

Although this sequence of construction is precisely that anticipated from the results of the earlier excavated sections, when combined with the broader survey and satellite data it nevertheless raises issues that require consideration. Firstly, by corroborating the combined excavation and survey evidence that suggests the group of fields to the south consistently pre-date those to the north, further questions are raised that have hitherto not been considered in detail: how does the field-by-field model of expansion defined above fit within the broader process that led to the construction of the whole North Fields area and, more specifically, what is the time lapse between the construction of the terraces to the south of the water channel and the creation of those to the north?

Clearly, feature [1] forms the boundary between these two groups of terraces since its southern side is consistently found to be earlier than the walls that form its northern bank, and these two sides are always stratigraphically separated by a deposit of coarse alluvial stones and gravels which demonstrate that the water channel remains in use. There are only two general models of expansion that would fit this repeating pattern: either the area of terraces is first expanded north by constructing a strip of fields along the base of the escarpment and is then subsequently expanded east by building a further strip or, alternatively, 'blocks' of terraces are constructed between watercourses. Since all of the watercourses at Engaruka run broadly east, the expansion pattern in this second model would initially be towards the east but would nevertheless gradually increase the area of terraced agriculture northwards as the channel that forms the northern boundary of the first block is employed to construct a subsequent block. The interpretation here is that this second model best fits the available data, and is perhaps a more likely scenario because it allows the watercourses closest to the habitation sites to be exploited first.

There are, of course, still too many externalities in this model to precisely characterise the expansion strategy and, as such, attempts to calculate the time lapse between the construction of the fields to the south and north of water channel [1] remain extremely difficult. For example, Sutton's surveys of this area of the North Fields demonstrate that the zone of cultivation extends over 2km to the east, and there is no reason to suggest that this limit was reached prior to any further expansion northwards. However, evidence from a further furrow junction excavated in 2002 may give an indication of the size of one block of fields. This section is situated approximately 120m to the east of the area of fields and irrigation features that were discussed in detail above, and was excavated in an attempt to investigate the relationship between feature [1] and a smaller furrow running NNE-SSW [51] (see figure 5.31 and figures 5.28 and 5.32 for location). The section initially presented a confusing picture, partly as a result of erosion damage to the features, and partly because the different styles of walling employed in the furrow suggested it may have actually been several structures of uncertain function. More significantly, although these walls were interpreted as a furrow (Pollard - archive), it was clear from levels taken in plan and in section that the furrow would drain south into water channel [1]. Since at this time [1] was viewed as primarily an irrigation feature in keeping with Sutton's 'artery canal' model, it seemed counterintuitive that a furrow should act as a tributary, rather than as an off-take. Re-examination of this feature in the light of subsequent work, however, suggests that it is a further furrow that employs an earlier terrace wall (45) as its up-slope side and that, moreover, it is fed from the broadly W-E running furrow [42]/[378]. Evidence from the excavated section does not conclusively demonstrate the contemporaneity of these watercourses however, though the upper fills (25 and 29) of [51] and [1] (here contexted as [48]) are both described as olive-brown fine silty-sand and both contained similar pottery types including fragments of horizontally incised ware that probably represent examples of

Robertshaw's (1986: 14 figure 13) types 11, 12 or 13. The deposit stratigraphically below the upper fills of both features (27) did not contain any pottery but appears to be the primary fill of [51]. It might be concluded, therefore, that both features were abandoned at the same time but this is difficult to confirm since [48] was not fully excavated.

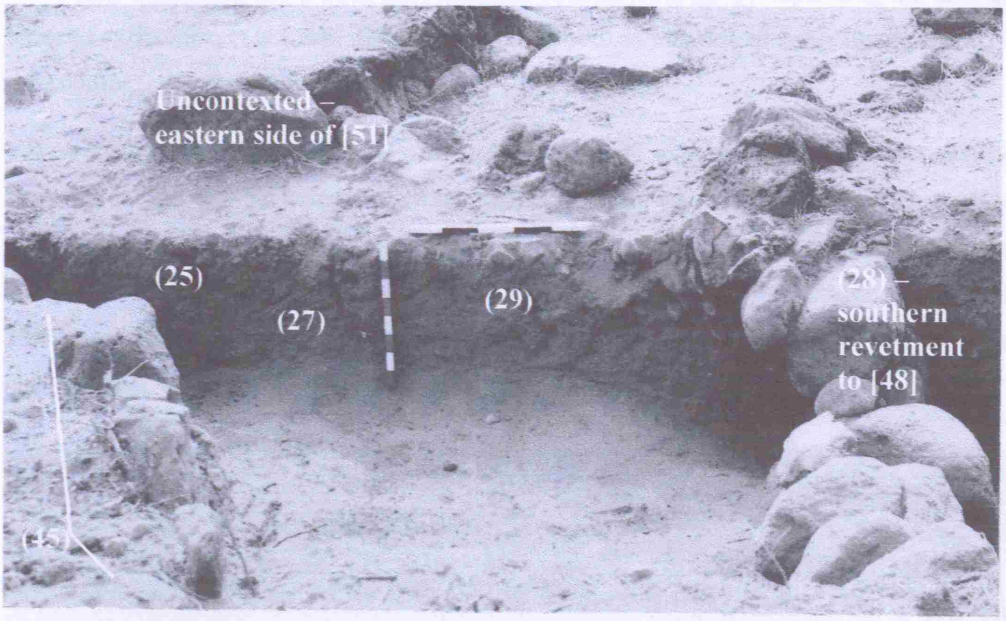


Figure 5.31: Furrow junction [51]/[48] looking east
Horizontal scale 500mm; vertical scale 400mm

Regrettably, the junction between [378] and [51] was not investigated and it is possible that [42]/[378] continues to the east. However, based on the currently available evidence it is possible to offer tentatively a refinement to the phasing summary presented above by dividing the North Fields area into blocks of terraces, with a block defined as a group of fields contained by their irrigation furrow. In terms of the area in the immediate vicinity of the excavated terraces, the fields to south of the main water channel are the first to be constructed as is evidenced by the fact that the watercourse's southern reveting wall (or more properly, series of walls) are consistently found to be earlier than those to the north. A series of terraces are then constructed by diverting water and sediments from this channel and containing these deposits within dry-stone walls. The resultant fields are watered by inserting a furrow that flows to the north of this group of terraces and which irrigates them through a series of off-takes that direct water back to the south towards the main channel, as is evidenced by damage to those terrace walls across which this water must flow. As more fields are built, this furrow is extended until the desired size for a block of fields is reached. The furrow is then diverted to the south so that unused water can flow back into the main water channel unimpeded by intervening terrace walls. Scaling up this process to look at the

Northern Fields more generally creates a problem however: if the blocks of fields to the immediate north of a watercourse are the first to be constructed, these would themselves impede the flow of water necessary to build subsequent blocks to their north. This means that the process of block creation just defined would be best viewed as a sub-phase. Before examining how these sub-phases fit within the broader strategy of expanding the area of terraced agriculture, it is worth discussing the implications in terms of water management of the additional data just presented.

By overlaying the combined 1:50 plan and EDM survey onto an extract from the satellite image, it is clear that the junction between furrow [51] and water channel [1] is not the only point where unused water flowing within an irrigation feature is directed into a larger watercourse. However, combining excavation and walkover evidence with aerial photographic interpretation indicates that unused water may be directed either back into the channel from which it was originally drawn, or into a further water channel to the north.

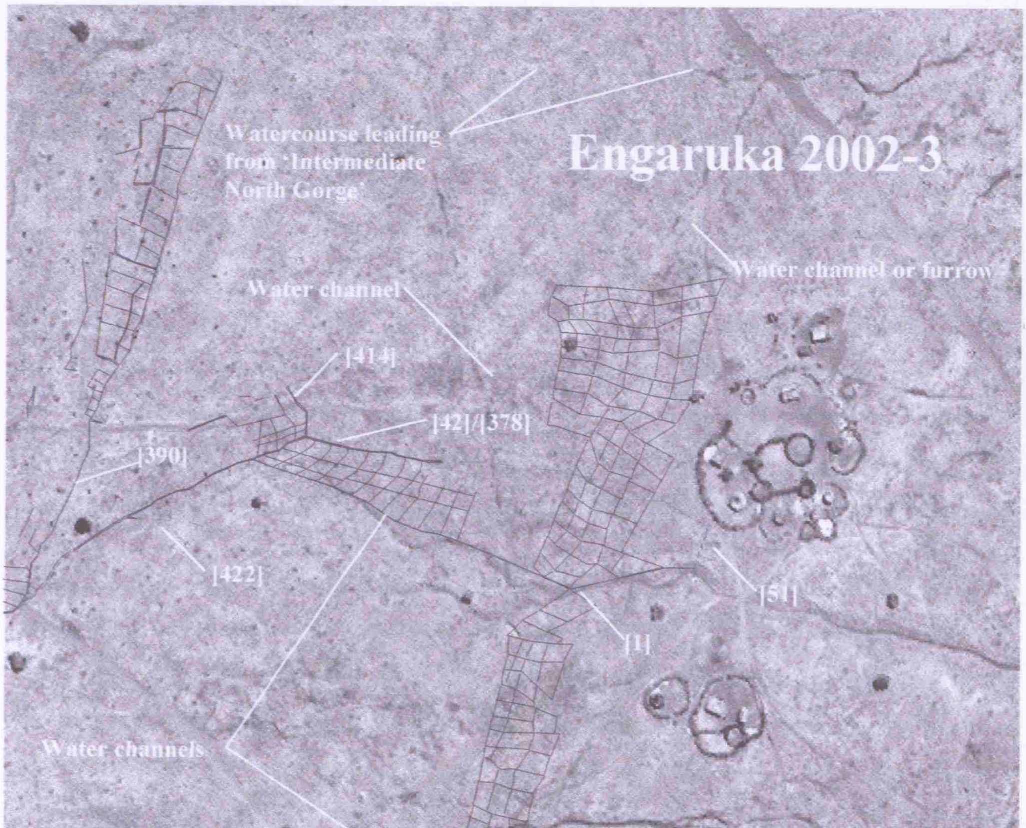


Figure 5.32: EDM survey and satellite image showing water management system

Note, for example, that water diverted from channel [1] along furrow [390] can subsequently empty into a further W-E aligned water feature located to the north, and thereafter can feed furrow [414] (see figure 5.32 above). Segments of this W-E aligned feature were visible in plan and were recorded by the EDM survey as a large furrow. However, the fact that this survey data corresponds with a curvilinear feature traceable on the satellite image would tend to suggest that it is a more sizeable structure, and therefore probably represents another water channel. Note too, that a linear feature running SSW-NNE is apparently fed from this channel and ultimately drains into the dry river bed that leads from the 'Intermediate North Gorge'. A further furrow that appears to represent an extension of [390] on the above image also drains into this river channel. If all these channels, furrows and terraces remain in use after subsequent blocks of fields are constructed, then this network of interconnected watercourses represents an extremely flexible approach to water management, since it could function to allow individual fields to be irrigated from a variety of artery canal off-takes.

This last point raises an obvious question that has thus far not been addressed: does the construction of new fields lead to a corresponding abandonment of earlier terraces. Questions of this sort are difficult to answer through the examination of structural remains since unless features are dismantled or are found to be stratigraphically earlier than structures or deposits which relate to later exploitation, it may be hard to distinguish fields that were abandoned during the period of occupation from those which were abandoned when occupation ceased. Nevertheless, one further section through a junction in feature [1] does indicate that older areas continue to be used or, at least, are later re-employed. This section was excavated at a point virtually equidistant between the channel [1] off-takes for furrows [390] (located 55m to the SW) and [378] (located 57m to the NE) at a point where this channel (here contexted as [362]) meets a further furrow [422] (see figure 5.28 for location).

This junction was excavated because it appeared in plan to represent an off-take from channel [1] that runs to the ESE and thus was the only area identified where this channel was employed to irrigate fields on its south side. The first part of this feature to be investigated was a 1m wide segment inserted through a discrete element of the channel 2m to the NE of the furrow junction (see figure 5.33 below). The intention here was to establish the chronology of the construction of the channel at a point uncomplicated by the intersection with the furrow. The sequence revealed was as one might expect on the basis of the results presented above: an early southern wall (364) constructed from large (upwards of 500mm x 500mm x 500mm) boulders, followed by a shallow deposit of coarse gravels (441), and then the construction of the northern wall (363), here consisting of seven courses of stones averaging roughly 100mm in diameter. Thereafter a further deposit of gravels (365) was deposited at the base of the channel, physically and stratigraphically sealing the lowest two courses of the northern channel wall (363). This is obviously something of a simplification as results presented above would suggest that revetment (363) may consist of two construction episodes which themselves relate to a series of channel extension and silt deposition events, however, for the purposes of the current discussion it is sufficient to note simply that the stratigraphy at this juncture is in line with the sequences evidenced elsewhere. Similarly, a discrete section excavated through the furrow [422] 1.5m from the point of intersection demonstrated a construction process familiar from previously excavated segments, where what is probably a pre-existing terrace wall (357) is extended and re-employed to act as the up-slope side of the furrow, whilst the down-slope side (423) is constructed from larger stones in an attempt to reinforce the area that will take the brunt of the water flow. The deposit that later accumulates within this feature (358) consists of fine silty-sand, indicating that this furrow was not subjected to the strengths of flow that deposited the much coarser (441) and (365) within the water channel.

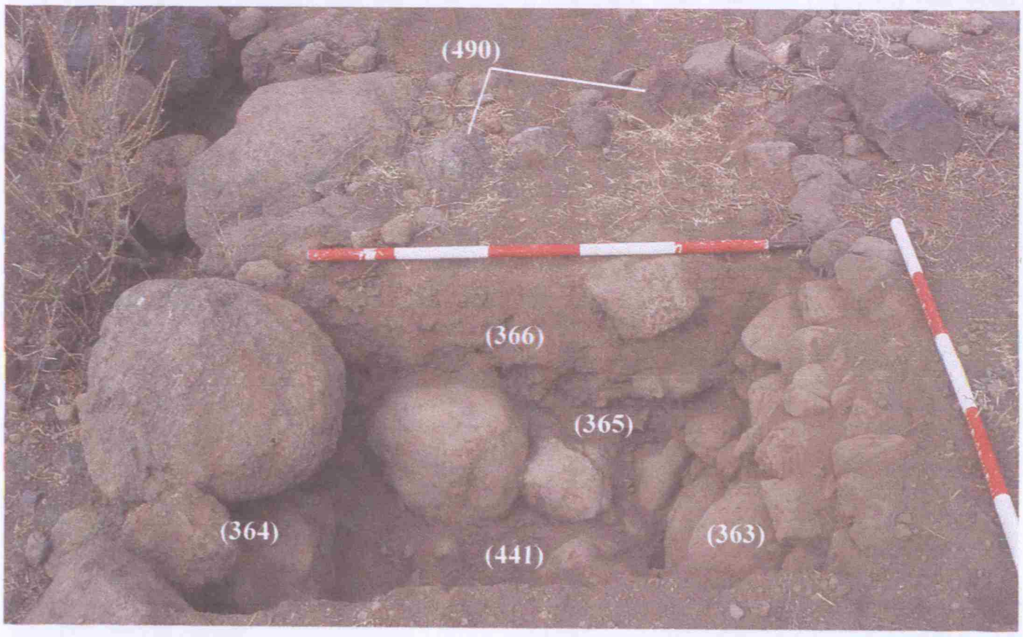


Figure 5.33: East facing section through [362]. Scales 2 x 1m

The excavation of the point of intersection between these two features demonstrates that both of the furrow walls (357) and (423) partially overlie channel deposit (365) – see figure 5.34. Since it is known that water channel [1] was in use when the fields within the principal excavation area were constructed, the stratigraphic position of (357) and (423) above a late fill of channel [1] is clear evidence of modification to the area of fields to the immediate south. To put that same conclusion another way, since (365) was deposited after the construction of the channel's southern side (364), and (364) represents an element of the fields to the south of the channel, then the fact that the later furrow [422] cuts (365) indicates a time lapse between the construction of these fields and the insertion of the furrow. Whether the construction of [422] represents a major modification to the fields to the south is not known however, though tracing the line of (357) and (423) to examine their relationships with further terrace walls should give some indication. Either way, it is also interesting to note that at some point following the construction of furrow [422] the water channel [362] is allowed to silt-up and thus goes out of use. It is not known whether [422] remains in use during this period but note too the insertion of a single-coursed line of stones (490) that overlies the terminal deposit within the channel (see figures 5.33 and 5.34). The function of this stone line is not clear but it nevertheless serves to indicate that this area remained in use following the channel's redundancy as a watercourse. Given its location it seems reasonable to conclude that (490) served some agricultural function, but without identifying further features that relate to this late stage it is impossible to characterise what form this later activity took. Indeed, at present it is not even possible to ascertain whether this later activity employed irrigation, though the fact that (490) was built after channel [1]/[362] had been allowed to silt-up might suggest that this period of later land-use was very different in character to that in operation at the time in which the terraces were first constructed.

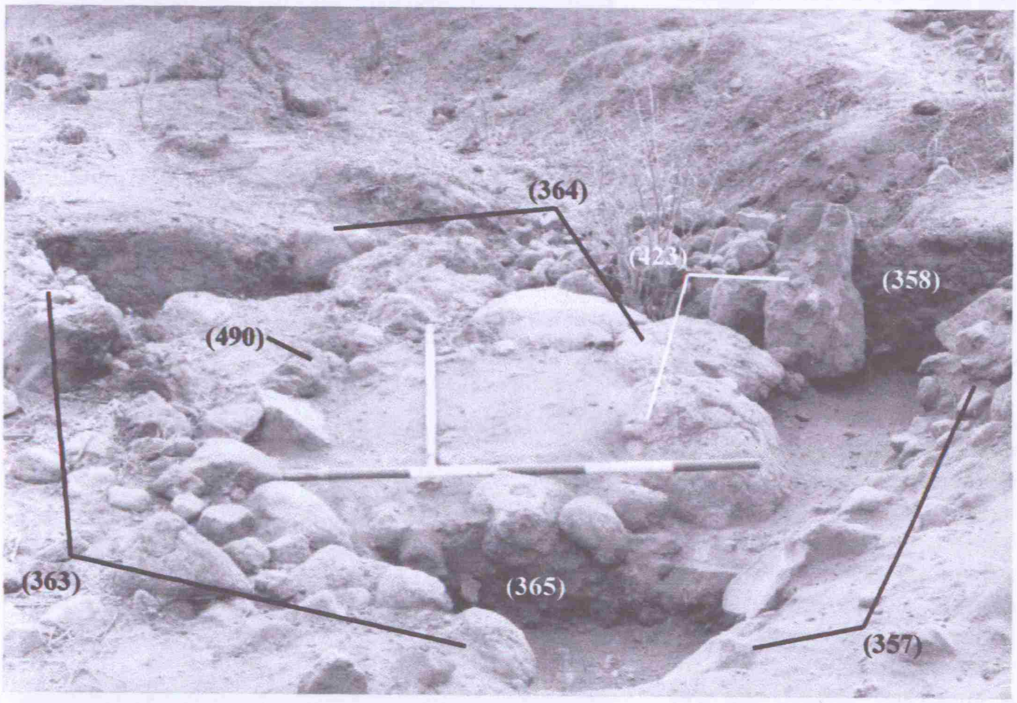


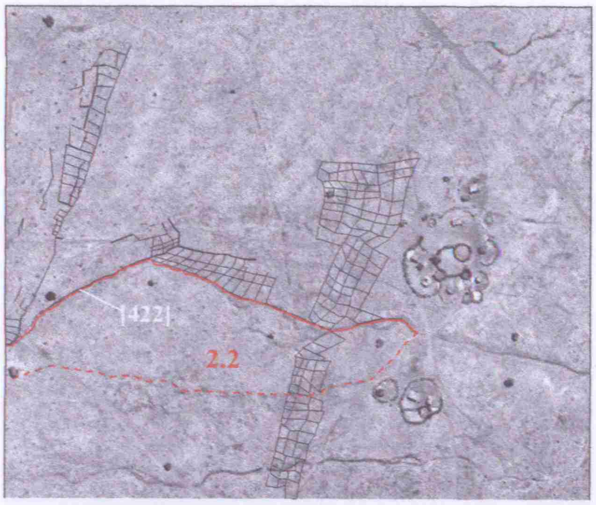
Figure 5.34: Water channel and furrow junction [362]/[422] looking east. Scales 2 x 1m

By combining the excavation and survey results presented above, it is now possible to broadly phase the construction of the terraces in the immediate vicinity of the main excavation area. In the following summary fields built from different watercourses are assigned separate phases. These phases are then sub-divided into blocks of terraces as defined above as a group of fields built from sediments carried within an individual watercourse and then subsequently enclosed by their attendant irrigation furrow. It should be clear from the preceding discussion that considerable ambiguity remains as to the precise sequence of construction. Nevertheless, based on the currently available evidence the process of expansion of the area employed for irrigated, terraced agriculture in the North Fields can be broadly characterised as follows:

Phase 1: The earliest phase of construction evidenced on the combined EDM plot and satellite image (left) is the group of terraces to the south of the southernmost watercourse. The alignment of this watercourse – like that of channel [1] – is reflected in the orientation of a modern erosion gully which has revealed sections of dry-stone walls that appear to represent surviving fragments of channel revetments. This watercourse seems to have drawn water from an 'artery canal' identified by Sutton, who notes that this canal could have been fed from both the Intermediate North Gorge and the Engaruka River (see figure 5.2 above and sketch plan in Sutton 2004: 115). However, the orientation of the fields south of this canal strongly suggests that the phase 1 fields are constructed from sediments carried by a further watercourse located to the south.

Phase 2.1: The terraces in phase 2.1 are constructed from sediments captured from the watercourse that leads from Sutton's artery canal. This may also be the case for the phase 2.2 fields, though further excavation would be necessary to ascertain whether the erosion gully evident in the satellite image (shown here as forming the boundary between these two sub-phases) represents a channel of the feature [1] type or is instead evidence of the line of an irrigation furrow.

Figure 5.35: North Fields phasing summary (continued below)



Phase 2.2: Following the construction of the fields in phase 2.1 a further group of terraces are constructed to the north. Some of the wall extension/terrace containment walls that form the northern extent of this phase also act as channel revetment walls for the south-side of feature [1], the southern side of which is consistently found to be earlier than the walls that form its northern side. It is possible that furrow [422] follows the line of an earlier furrow or water channel and thus may form the boundary of a further sub-phase. As with the phases illustrated above, the eastern extent of this block is not known definitively, though it is possible to discern a faint linear depression linking channel [1] to the erosion gully that is interpreted here as the southern side of phase 2.2. This line is tentatively interpreted as a furrow and thus shown as the block's eastern limit.

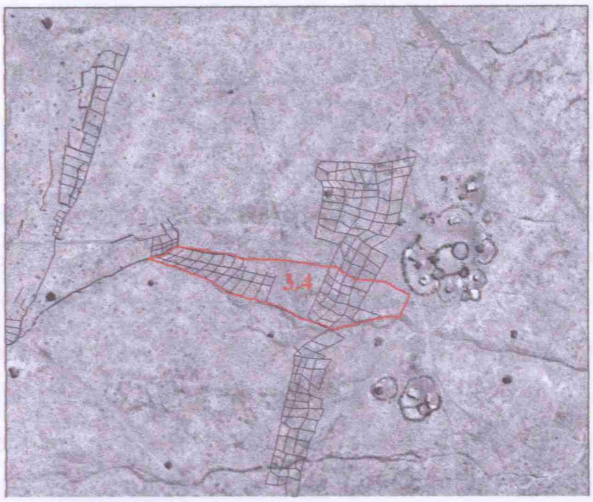
Phase 3: Terraces built from channel [1]. This phase is the best understood since it includes the furrow junctions and fields defined through excavation. Nevertheless, considerable ambiguity remains. For example, if furrow [422] reflects the line of an earlier water channel, then the group of fields bounded by this feature to the south and by channel [1] to the north would represent an early element of phase 3. Caveats of this kind notwithstanding, the summary presented here offers the most precise characterisation of the expansion of the North Fields terrace system to date.

Phase 3.1: A group of fields (most of which are outside the frame of this illustration) are constructed to the north of channel [1]. These are bounded to the north by a further probable water channel, and to the east by terrace (369)/(373) that will later form part of furrow [390].

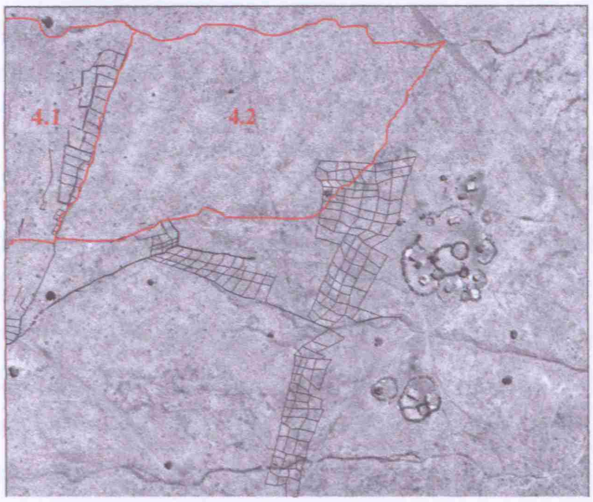
Phase 3.2: A further block of terraces are constructed from sediments carried within channel [1]. The block is bounded by [1] to the south, by a further probable channel to the north, and by furrow [390] to the west. The eastern extent is formed by furrow [414], or by the terrace wall (409) that later forms part of this furrow.

Phase 3.3: The group of terraces to the east of 3.2 and to the north of the main excavation block 3.4 are constructed. Wall (331) forms its southern extent. The eastern limit of this block is not known and is thus inferred from the extent of phase 3.4.

Figure 5.35: North Fields phasing summary (continued below)



Phase 3.4: The main area investigated through excavation is constructed. The block is bounded to the south by [1], to the north by furrow [378]/[42] and to the east by furrow [51]. Furrow [378]/[42] provides the means of irrigation whilst [51] acts to return unused water back into the water channel. The block comprises some 90 terraces, averaging 6m x 6m.



Phase 4.1: A group of fields between those built in phases 3.1 and the water channel that leads from the Intermediate North Gorge are constructed. The eastern extent of these fields is clearly discernible both in plan and from the remote sources, as are a series of furrows and furrow fragments that would suggest this area comprises several further sub-phases.

Phase 4.2: A further group of fields to the east of phase 4.1 are built. The alignment of these terraces is also clearly visible from the satellite image, and appear as a succession of light and dark strips as noted by Sassoon (1967). This alignment indicates that these fields were built from sediments captured from the watercourse to the south, with the Intermediate North Gorge river bed forming their northern boundary. As with the area built in the preceding phase, this group no doubt contains several as yet unidentified sub-phases.

Phase 5: In broad terms, further blocks of terraces are constructed to the north of the water channel that flows east from the Intermediate North Gorge, and to the east of the fields built in phases 1 to 4. In addition, furrow [422] is constructed in order to re-employ or augment fields built in phase 2.2. The construction of stone line (440) demonstrates that there is continued activity in this area after the abandonment of channel [1].

Figure 5.35: North Fields phasing summary

The development of the field and irrigation system at Engaruka

Having identified what appears to be a repeating pattern of field construction in the area surrounding the excavated terraces and irrigation features it was necessary to establish whether this construction process was employed in other areas of the field system. The aerial photographs and satellite image were therefore reviewed, and areas with well preserved field layouts as evidenced in these sources were examined on the ground. Since the level of vegetation cover to the north of the excavation area limited visibility from the air, a transect was also walked northwards from the dry river bed that leads from the 'Intermediate North Gorge' to the Lolchoro river. Although, without excavation, it was not possible to determine the stratigraphic relationships between the features identified during this walkover, the orientation of field walls in relation to furrows and possible water channels suggests strongly that most if not all of the terraces in the North Fields were constructed in the manner and sequence described above.

The same would also appear to be the case for large areas of the South Fields (see figures 5.7 and 5.36), and for sections of the Central Fields to the immediate north of the Olemelepo (figure 5.37) and at the eastern extreme of the field area to the south of the Engaruka (see Sutton 2000 [1998]: 18 figure 12). Figure 5.36, for example, shows a detail of a well preserved area of irrigated fields covering some 60ha located roughly 1km to the south of the Olemelepo and centred at approximately 35°57'57''E, 3°1'11"S. Once again, the alignment of field walls in relation to large watercourses would seem to indicate that these features were built using the same techniques employed in the North Fields and, indeed, since they are predominantly aligned NNW- SSE it would appear, as is to be expected, that the terraced area in this location expanded incrementally to the south and east. Moreover, from the examination of the stratigraphy revealed by erosion gullies and rills, it is clear that the fields in this area generally consist of low terraces that rely on the prior deposition of the sediments they contain, whilst the identification of several examples of the characteristic 'damming stones' that were commonly found in the excavated furrow off-takes would seem to indicate that a similar system of water management was employed in both the North and South Fields.

However, although some areas to the immediate north and south of the Olemelepo also appear to conform to the model presented above, it is clear that there are anomalies that cannot be dismissed at present as merely the result of topographical differences. One such area has previously been highlighted by Sutton (for example 2000 [1998]: 14-15) who notes the presence of what he terms 'embanked furrows', some of which overlie earlier field walls.

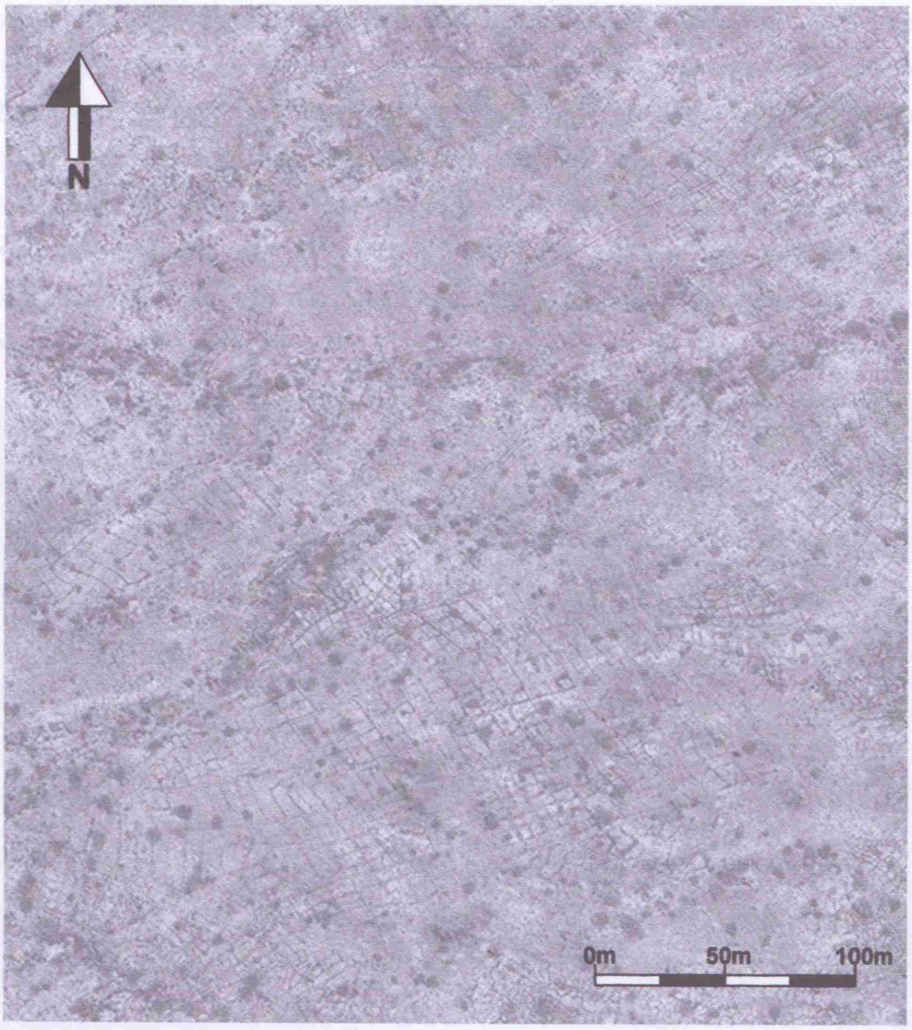


Figure 5.36: Detail of satellite image showing fields and irrigation features, South Fields

Built in the same fashion as the cairns and stone circles by containing a rubble fill within well-coursed dry-stone walling (see figure 5.39 and 5.40), these features are most obvious on the north bank of the Olemelepo where their association with the river clearly indicates that they relate to the management of water. By taking levels along the length of several surviving examples, Sutton (2000 [1998]: 14) notes that they maintain a steady angle of descent and thus interprets them as bases for furrows made from hollowed logs, and sees their apparent superimposition over earlier field walls as evidence that the original method of irrigating these fields proved to be insufficient. However, not all of these features post-date neighbouring fields. Figure 5.37, for example, shows an 'embanked furrow' located to the immediate north of the Olemelepo and south of the watercourse referred to by Sutton as the Olemelepo 'artery canal' (visible in figure 5.37 as a line of trees – see also figure 5.2). The image is centred at approximately 35°57'33"E, 3°0'40"S, and shows the same feature as that depicted from the ground in Sutton 2000 [1998]: 15 figure 8, where it is clear that the top of the raised bank is now approximately level with the surrounding fields. That this feature is a substantial structure is nevertheless clear on the ground where its revetted sides and rubble infill can be seen in plan, and where several courses of dry-stone revetment are evident in areas crossed by erosion gullies. Since there is no obvious reason why this feature should have been built within a deep foundation cut, it would seem that one or both of its revetted sides would have been exposed in the period immediately following its construction, and that consequently some of the material that now physically overlies the structure must have been deposited after it was built.

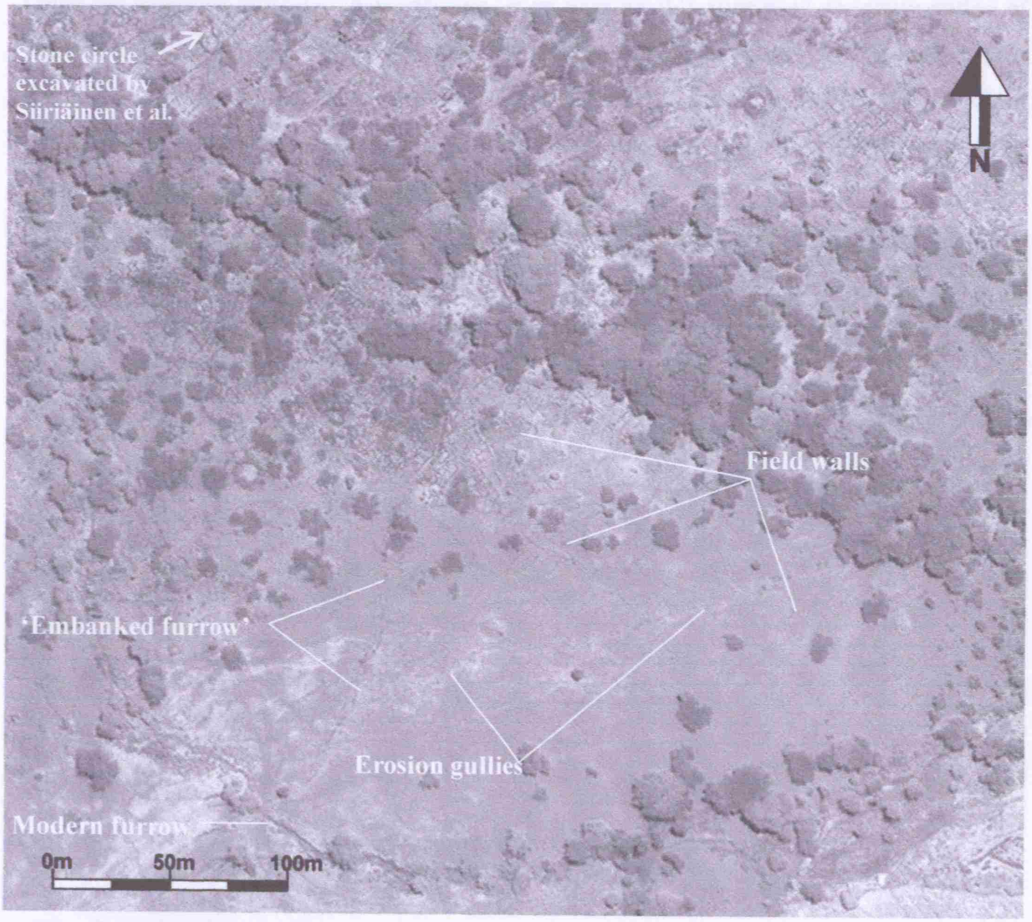


Figure 5.37: Detail of satellite image showing 'embanked furrow' and associated fields

Examination of erosion sections through the field walls to the east of this bank show that, like those in the North fields, these walls consist of multiple courses of stones, the lower courses of which have subsequently been buried. Measuring up to 0.6m in height, the examined examples all slope downwards in the direction of the 'artery canal' and thus are very similar to those in the excavation area. As with the North Field terraces, therefore, these walls must post-date the layers they revet and thus almost certainly also post-date the 'embanked furrow'. These combined observations would seem to call into question Sutton's suggestion that these linear structures represent evidence of a system under pressure, not least because they do not appear to be a very late element in the sequence of site construction. Moreover, in the light of the excavation results from the North Fields, it is possible that the 'embanked furrows' relate to the creation of terraces in this area and may indeed be check-dams not dissimilar from those described by Hill and Woodland (2003) in reference to indigenous agriculture in Tunisia. Such an hypothesis would, of course, need to be tested through excavation, but need not contradict Sutton's interpretation of these features as their position and alignment would make them ideally suited to be re-employed as the bases for irrigation furrows. Nevertheless, even without this suggested re-interpretation of the embanked structures, the recognition that the other features in this area broadly mirror those investigated through excavation (see figure 5.38) would seem to indicate that much of the agricultural landscape in the vicinity of the Olemelepo was built using similar techniques to those employed to the north of the Engaruka.

Figure 5.38: Furrow leading from the Olemelepo 'artery canal'
Note upslope edge appears to be a coursed-wall forming a terrace

The foregoing discussion notwithstanding, it should be noted that although the majority of the 'embanked furrows' to the north of the Olemelepo 'artery canal' are obscured by the deposition of alluvial gravels and medium to large stones (see figure 5.39), these examples would not seem to have been designed to aid in the capture of sediments to be incorporated within terraces, and indeed in several places these features appear to overlie earlier field walls. Figure 5.40 shows one of the more clear cut examples of this latter type from the central fields, whilst the embanked section of the 'great northern canal' (see p. 154, 159 and 174 above) is another. Such examples therefore correspond more closely to Sutton's conclusion that features of this type represent attempts to extend the area of irrigated agriculture, though to address the question of their position within the chronology of the site it would be necessary to establish the relative age of the latest fields sealed by these structures, and to ascertain whether the embankments are built in a single phase or are gradually extended. In terms of site chronology therefore, these features pose similar questions to those raised by the stone circles and cairns with which they apparently share a construction technique. However, of equal interest is the fact that these various revetted rubble structures within the Central Fields are situated within field layouts that differ from those evidenced to the north of the Engaruka and to the south of the Olemelepo.

Figure 5.39: Revetted rubble embankment to the immediate north of the Olemelepo.

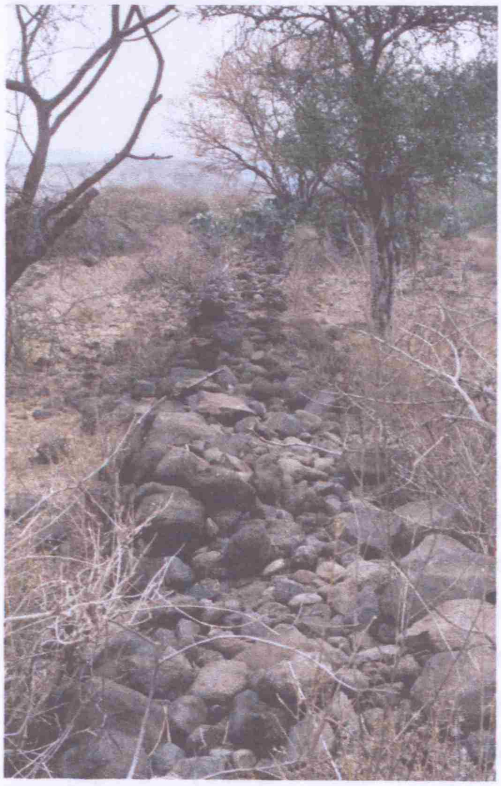


Figure 5.40: Embanked furrow, Central Fields, looking NNE

As noted above (pp. 153-4, see figure 5.4) fields in the central area generally consist of simple lines of medium-large stones forming sub-square divisions. Although low terraces are found within this part of the site these are restricted to the sides of small hills and stony outcrops, whilst open areas with slopes of up to 1:30 are not contained by revetments. Fields thus appear as a parallel grid pattern when viewed from above, with the network of furrows dissecting them at right-angles (see figure 5.41). Permanent furrow off-takes like those excavated in the North Fields and inferred from damming stones in the South Fields are not seen in this central area, indicating that plots were probably irrigated by removing one or more of the boundary stones; an approach similar to that employed at Sonjo and Marakwet where fields are watered by simply breaching the furrow bank with a digging stick or hoe (Adams, Potkanski and Sutton 1994: 29; Watson, Adams and Mutiso 1998: 79). It is clear, therefore, that the size and shape of the plots within the Central Fields is not a consequence of the technique of construction as appears to be the case elsewhere on the site. As such, it would seem that this arrangement of fields is not directly related to the improvement of the cultivation area, since bounding plots with single lines of stones neither increases soil depth nor levels fields to improve the drainage or retention of water. Similarly, whilst Sutton (for example 1984: 32 and 39) is no doubt correct in noting that the plot boundaries are probably made from stones produced during field clearance, this does not in itself explain the layout of land divisions since it would seem unlikely that the community would have allowed field size to be dictated simply by the need to dispose of unwanted stones.

Figure 5.41: Stone-bounded fields, terrace and irrigation furrow, Central Fields

That having been said, if the interpretation of the cairns as stone clearance features is accepted, then the presence of numerous examples throughout the Central Fields is clear evidence that the removal of large inclusions from cultivation layers was a continuing problem for which the building of tall, steep-sided rock piles offers a simple and elegant solution. Indeed, of the various interpretations offered for these features, stone clearance remains the most credible since the examination of their distribution within the Central Fields presents no obvious pattern, and the results from the previously excavated examples refute the suggestion that they may be burial markers. Equally, comparisons with other agricultural communities in the region do not support the suggestion that the cairns are granary bases, principally on the grounds that they are located at some distance from the habitation areas where stored grain could be better protected from pests and theft.

As clearance features, of course, it remains possible that these structures performed a secondary function, perhaps as bird-scaring platforms (Sutton 2000[1998]: 16) or as bases for the storing and drying of cattle manure (ibid.). However, in terms of site chronology it is their primary function that is of most significance since the continued construction of stone clearance features would present evidence of prolonged or recurrent cultivation. The presence within the field system of several cairns that have evidently been extended or built against pre-existing examples (see figures 5.42 and 5.43) would thus seem to be indicative of extended periods of tillage, but it is clearly necessary to establish whether the phase of cultivation to which these features belong took place before or after the division of the Central Fields into a series of small irrigated rectilinear plots. Unfortunately, since the previous cairn excavations were undertaken primarily to test the burial marker hypothesis, these investigations appear to have deliberately targeted discrete examples and thus the published accounts offer no information regarding the relationships between theses features and nearby field walls. For this reason the current project examined a series of cairns, two examples of which were partially excavated in order to demonstrate the relationship between these features and an adjoining terrace wall.

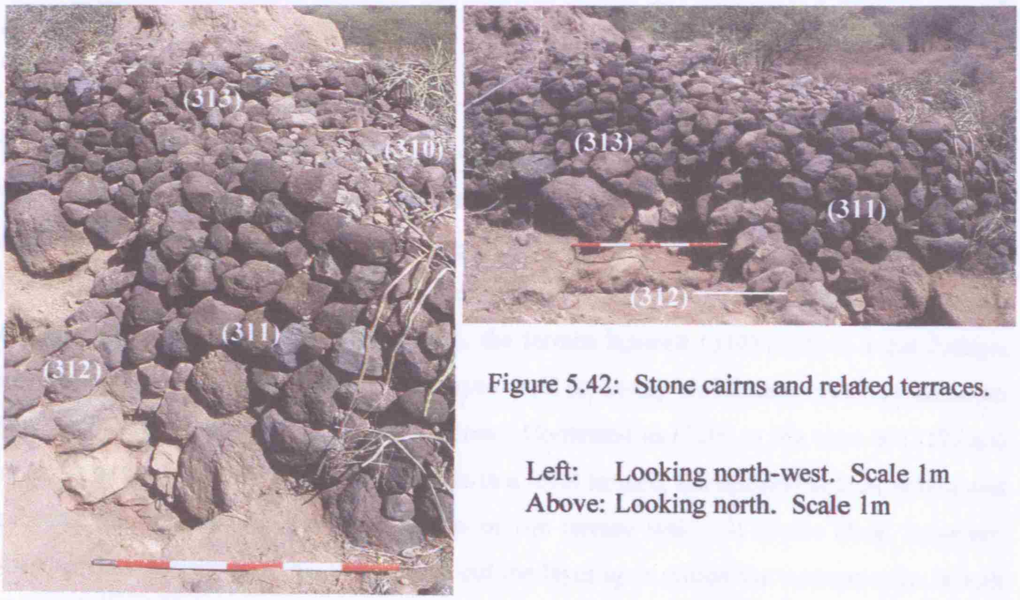


Figure 5.42: Stone cairns and related terraces.

Left: Looking north-west. Scale 1m
Above: Looking north. Scale 1m

Located at approximately 35°57'10"E, 2°59'50"S, roughly 175m to the south of the Engaruka river, the investigated cairns are situated within a small group of terraces, though these are themselves surrounded by the simple stone-bounded cultivation plots more typical of the Central Fields area. Prior to excavation it was evident these two cairns were not precisely contemporary, since the dry-stone revetment to the eastern feature (311) abuts the outer wall of the western feature (313), and indeed the loose rubble fill of the eastern cairn (310) physically and stratigraphically overlies part of the revetting wall to the western structure. Similarly, even without excavation it appeared that both (311) and (313) physically overlaid terrace wall (312), though in the case of the eastern cairn this could be seen more clearly following the removal of a small section of the cairn facing (see figure 5.42); a process which also demonstrated that (310) was deposited over the terrace revetment.

Although proportionately only a small section of (310) was removed, 14 pottery fragment were recovered comprising nine undecorated body sherds, three rim sherds, and two neck sherds of which one was of a fine reddish-brown fabric decorated with two incised lines separated by a band of short vertical – possibly stamped – punctates (Oteyo pers. comm.). There are no exact parallels for this decorative motif in the ceramic assemblages collected by Sassoon (1966: 86, 91 and 92) and Robertshaw (1986: 9-16), though the sherd is very similar to a surface find recovered by Siiriäinen et al. from the village area to the immediate south of the Engaruka river, and may match a further reddish-brown decorated sherd retrieved from 'layer 3' (i.e. between 30-45cm below ground level) in trench 2 within the same area (Oteyo pers. comm. – see also p. 184 above)[15]. However, Oteyo (2003: 10) considers that various combinations of grooves, stamps and punctates predominate on the decorated pottery recovered from trenches 1-3 in the 'South Village'.

The only other fragment of pottery from this area was a sherd of dark grey horizontally incised ware corresponding to Robertshaw's type 1, 11 or 11a (Robertshaw 1986: 15-16) which was recovered from the interface between layers (315) and (320), both of which were excavated in order to examine the stratigraphy below the western cairn (see figure 5.42). From this investigation and the examination of the full depth of (312) it is clear that, unlike the terraces excavated in the North Fields, the terrace beneath (310)/(311) is a cut feature, excavated through a fine, slightly silty, clayey-sand (or sandy clay loam) with very common (i.e. >30%) small to large, sub-angular stones. Contexted as (320) to the west of (312) and as (321) to the east, this layer was cut to form a level terrace, the upslope side of which was subsequently revetted by the construction of the terrace wall. It is not clear, however, whether the excavation of this terrace also cut the layer upon which the western cairn is built (315). Indeed it is possible that, having cut through (320)/(321) to create a level platform, the spoil from this excavation was sifted to remove the stones and was then 'shovelled' upslope to form a cultivation layer (315) which is then revetted by wall (312).

[15] This latter piece has a second line of punctates below the lower incised line, and is broken above the upper punctates. It is possible, therefore, that this second sherd may not have had an upper incised groove and thus might represent a different form or sub-form.

Either way, since both cairns physically overlie the terrace wall, both were built following the construction of this field division. However, whilst the basal course of (313) rests on a cultivation layer (315), (311) is physically founded on the base of the terrace cut delineated by the top of (321). This indicates that the lower levels of the eastern cairn must have been constructed prior to the deposition of layer (314), which is itself contained by a further low terrace to the east and was therefore probably deposited when this later terrace was constructed. As a relatively stone-free sandy-silt, (314) was presumably deposited in order to create a deep, level, easily-tilled layer for cultivation. As such, cairn (310)/(311) post-dates the cultivation of the terrace contained by wall (312) but pre-dates the cultivation of the terrace in which it is located.

Figure 5.43: Stone cairns and terraces following removal of part of cairn-facing (311). Scale 1m

The stratigraphic ambiguities regarding (315) notwithstanding, this brief investigation therefore demonstrates that the construction of cairns is an ongoing process which continues while further terraces are being built. Indeed, as structures built above ground it is probable that after their foundation they were continually or periodically heightened by the addition of further cleared stones, though of course such a process would be almost impossible to discern stratigraphically. These results thus offer qualified support to Sutton's (for example 1978: 47; 2000 [1998]: 16) observation that cairns often overlie field divisions, and that in some cases cairns are themselves sub-rectangular in plan and apparently closely respect the boundaries of the fields onto which they have been built. It should be noted, however, that this relationship may be reversed, and that in the above example whilst the western cairn respects the line of (312), the north side of the terrace wall that contains (314) respects the position of cairn (310)/(311).

Although undertaken primarily to examine the relationship between field walls and cairns, the investigation outlined above also produced a result of equal significance by demonstrating that the terraces in this instance are formed by cutting into underlying layers. It is evident, therefore, that these terraces are very different from those in the North and South Fields; a recognition that would itself account for the question of why stone cairns are only found within the Central Fields, because the North and South Fields were formed by the accumulation of alluvial sediments that are relatively free of stones, whereas those in the central area were formed by the excavation and tillage of stony ground. The cairns can thus be seen as a direct consequence of the preparation of agricultural land, and it is therefore only to be expected that they would continue to be extended and constructed throughout the period in which this area was cultivated (Sutton 1986: 40).

Generally assumed on the basis of similar construction styles to be contemporary with the stone cairns, it might be supposed that the same conclusion applies to the stone circles, though since there appear to be no examples where cairns and enclosures are in physical contact the question of their stratigraphic relationship could not be addressed directly. Moreover, although these two categories of feature are often found in close association, the field walls in these areas are invariably single lines of stones and thus cannot be placed within a stratigraphic sequence by simply tracing the relationships between them. Indeed, the apparent association between cairns and circles has been seen as supporting the conclusion that they are contemporaneous, but this observation is qualified by Sutton (1978: 46) who notes that whereas the cairns are distributed across the whole of the Central Fields area, the enclosures are limited to locations close to either the Engaruka, Olemelepo or Olemelepo furrow, with the only exception being the small group of relatively large, low-walled examples in the North Fields (see figure 5.2).

As regards earlier work, Sassoon (1966, 1967, and 1971 – see pp. 160-1 and 165 above) concluded that the enclosures were relatively late within the sequence of site development, whereas Robertshaw (1986: 17-18 – see p. 172) employed the available radiocarbon data to suggest that the stone circles were comparatively early. Interpreting these structures as stock enclosures belonging to the community that occupied the hillside villages, Sutton (1978: 46-7 and 58) initially saw the circles as late elements of the site on the grounds that several examples have field boundaries running through them, but revised this view following Robertshaw's excavation to argue that "presumably they were built over time as the field system expanded and underwent modification. In fact it looks as if many of the enclosures were built to incorporate the existing wall lines of selected field plots, their outer revetments (as with the cairns) being simply raised field walls" (Sutton 1986: 40). Nevertheless, by viewing them as features built partly with the intention of accumulating manure to improve soil fertility and structure, Sutton (2000 [1998]: 18) considers it likely that most belong to a late phase of occupation in which soils were becoming increasingly poor, and that consequently "It may be that these [circles] were usually sited on land which was already expendable, being denuded of soil". Such a conclusion, however, is contradicted by the results of the stone circle excavation undertaken by Siiriäinen et al. in 2002, and by a comprehensive ground survey of other examples carried out by the same team the following year (Siiriäinen et al. 2004: 12-13 – see pp. 178-9 above). These investigations demonstrate that in numerous examples furrows and field boundaries respect the position of stone circles, with the former often clearly diverted around or through these earlier obstacles. Moreover, as Siiriäinen et al. (2004: 13) highlight, in those examples where field lines are visible within stone circles, it is difficult to imagine them remaining undisturbed if the enclosures are later additions employed as either stock corrals or habitation sites.

The partial excavation of a further stone circle undertaken by the current project supports the conclusions of the Finnish team particularly in respect of this latter argument, since the single-coursed stone lines (309) that divide the interior of the investigated circle simply rest upon a fine sandy silt (316) – see figure 5.44. The stone lines could thus not have survived within a stock enclosure and would seem likely to have proved somewhat annoying on the floor of a domestic structure. More precisely, (309) – conceivably laid out in phases but treated here as a single depositional event – abuts the enclosure's internal dry-stone revetment wall (307), and although the west-east alignment of elements of (309) is reflected in the orientation of further stone lines to the immediate west of the circle, these walls (304) abut the enclosure's external wall. For the stone circle to be later than the stone lines, therefore, the enclosure would have to have been carefully built within a foundation trench. Although the use of wall foundations is not recorded in the archaeological or anthropological literature for rural eastern Africa, this possibility was nevertheless tested by excavating two 2m x 4m trenches on either side of the circle's western wall.

The circle itself is located at approximately 35°57'24"E, 2°59'57"S, and measures 15m across on the west-east axis and 13.8m north-south. There is a single entrance on the east side measuring 0.6m at its narrowest point. The wall of the structure is up to 2m wide at its base, with the rubble in-fill accounting for approximately half the width. In the excavated section the wall measured 1.44m in height, of which roughly 1m lies above current ground level. Excavation thus revealed the basal course of (307) which consisted of large, rounded to sub-angular stones of up to 400mm in diameter. The wall does not rest on a deposit that could be interpreted as a floor like that encountered in the example excavated by Sassoon

(1964: 86 – see p. 163 above), and neither was the wall founded upon a firm, stony layer as was the case in the circle investigated by Siiriäinen et al. (2003a: 3 – see p. 179). Such a floor would, of course, have demonstrated definitively that the stone lines post-date the construction of the circle, but the absence of any suggestion of a foundation cut for walls that are battered from the base yet are neatly abutted by the stone lines, also serves to demonstrate that the enclosure must pre-date (309).

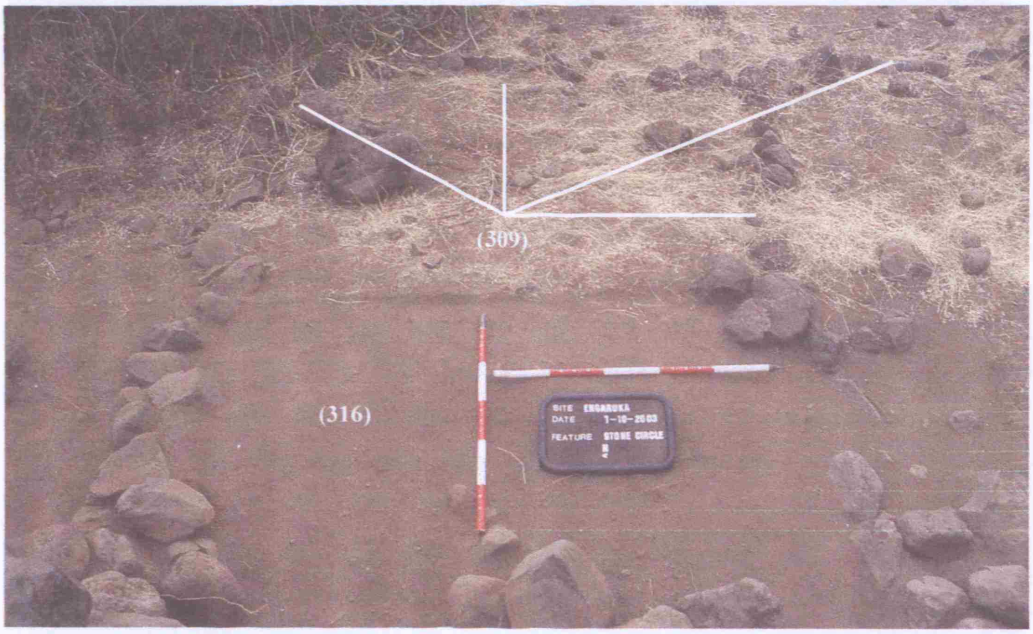


Figure 5.44: Stone lines within stone circle, Central Fields, taken from top of enclosure wall looking east. Scale 2 x 1m

As noted, (309) rests upon a mid-greyish-brown, fine sandy-silt (316) up to 290mm in depth and which contained a small quantity of very fragmentary bone. This overlies a shallow layer of compacted sand (318) 100mm in depth and measuring >400mm by >200mm, though this deposit was only encountered in the south-east corner of the excavated area. Below (318) was a further layer of mid-greyish brown fine sandy silt, very similar to (316), but which contained a higher proportion of stones including occasional (i.e. >10%) medium to large stones of up to 300mm in diameter. This deposit (317) extended across the whole excavated area and had a maximum depth of 260mm, from which was retrieved roughly 600g of very fragmentary bone along with 12 sherds of pottery, including three further examples decorated with two horizontal grooves separated by a band of punctates. Although the incised grooves are very faint in two of the pieces, and one of these is a dark grey rather than reddish-brown fabric, these sherds nevertheless closely match the example retrieved from the loose rubble cairn fill (310). A further small sherd of reddish brown fabric decorated with an incised – or possibly stamped – zig-zag pattern forming a broadly horizontal band, was also recovered from this context. This decorative motif would appear to be unique for the site (Oteyo pers. comm.).

The temptation to equate similar pottery styles from the 'South Village' (Hillside 2), the cairn and the stone circle with the same phase of occupation should be resisted however, not least because the results of recent work call into question conclusions of this sort drawn by previous researchers. The recovery of pottery fragments corresponding to Robertshaw's type 11 from the North Fields, for example, negate earlier inferences that the apparent relationship between this ceramic type and the stone circles suggests that both belong to a distinct culture (Sassoon 1967: 216) or distinct phase of occupation (Robertshaw 1986: 17). Indeed, on the basis of the circles investigated by Siiriäinen et al. and the current project, it would appear that the excavated deposits within these features all relate to a phase of use that post-dates the period of original construction; a conclusion reached earlier by Sassoon and endorsed by Robertshaw (see p. 172 above). It could be argued, therefore, that ceramic type 11 is associated with cultivation since it has thus far only been retrieved from areas that were built or re-used for arable production, but such a conclusions is no doubt equally premature. This is not to say, however, that the definition of a seriated ceramic typology for the site may not be possible in the future, merely that in order to establish a pottery-based chronology it would be necessary to achieve a far better understanding of the stratigraphic development of the area, and to relate the recovered ceramics to this sequence. Thus while all of the stone circle excavations have attempted to preserve the structures themselves, it would now seem necessary to partially dismantle several examples in an attempt to recover well stratified datable – or potentially datable – material.

Nevertheless, accepting that of the six investigated stone circles only one was fully excavated, this would still represent a roughly ten percent sample of these features based on reviews of the aerial photographs (Sassoon 1966: 85) and satellite image (Laulumaa pers. comm.) which put the total number at approximately 50. With the exception of that excavated by Leakey for which the published account offers insufficient detail, all of the investigated circles would seem to be earlier than the features around them; a conclusion that is supported by the survey of enclosures conducted by Siiriäinen et al. (2004: 13). At present, then, it would be reasonable to conclude that these structures relate to a period of occupation that pre-dates the division of the Central Fields area into irrigated cultivation plots, though this of course does not mean that this area was not cultivated during the phase in which the circles were constructed. The assumption that the circles and cairns are broadly contemporary must be rejected therefore, since the former were apparently built prior to the division of the Central Fields area, whilst the latter were constructed as a consequence of this division.

That having been said, the original function of the circles remains uncertain. The lack of any internal post-holes or post-bases would seem to argue against them ever having been roofed habitation structures, though once again only Sassoon excavated a sufficient quantity of the internal deposits to be certain, and even here the decision to excavate in spits may have distorted the results. The interpretation of the circles as stock enclosures would thus appear, at present, to remain the most convincing explanation and would account for the slightly elevated phosphate levels within and around these features (see below) as well as for the generally fragmentary and abraded condition of the finds (Oteyo pers. comm.; Sassoon 1966: 88), though Robertshaw's (1986: 17) conclusion that stock stallage may have been a secondary function cannot be discounted. Moreover, the stock enclosure hypothesis is not contradicted by the later sub-division of these features into what can only be agricultural plots, since the circles would then contain extremely fertile soil. The recognition that these features are sited in areas close to water sources (Sutton 1978: 46), however, would fit with both the stallage and habitation hypotheses.

Regardless of the original function of the circles, the decision to later sub-divide even these relatively small areas into agricultural plots raises interesting questions. Whilst it could be argued that this decision indicates that it was seen as imperative that all available land was cultivated, such an argument is easily countered by the recognition that if the original function of the circles had been fulfilled, there was then no reason not to exploit the areas within them. However, this does not in itself explain why areas as small as $60m^2$ would be later divided into rectilinear plots of as little as $8m^2$. Since the stone lines that form these plots are evidently not the upper courses of terraces and thus do not increase soil depth or aid in the retention or drainage of water (and indeed the examples within the stone circle investigated by the current project were not associated with a furrow), they cannot be seen as a method of directly improving the cultivation area. They must, therefore, have either served as a means of demarcating ownership or cultivation rights, or acted as guides for agricultural processes such as fallowing, watering, manuring or crop rotation. Discussing the possible function of stone lines associated with cairns and grindstones on the islands of Lolui, Buvuma and Bugaia, Posnansky, Reid and Ashley (2005: 94) opt for demarcation as the most likely explanation, and argue that comparisons with the intensive agriculture on Ukara (ibid. citing Thornton and Rounce 1936) suggest that such features are associated with densely planted cereals such as finger millet (see also p. 111 above). Such a conclusion may be equally applicable at Engaruka though it should be remembered that there is as yet no direct evidence for the cultivation of eleusine at the site. Nevertheless, given that the size of plots varies considerably across the Central Fields area, and that the dimensions of fields do not appear to be divisible by a constant factor, it would seem unlikely that these divisions represent allocations of land. Thus whilst it was argued above (see p. 83) that caution should be exercised in equating land division with rights of ownership or with intensive production, and in particular that such features need not be indicative of a "short fallow regime" (Kirch 1994: 234; see also Leach 1999: 315), the small size of the plots within the Central Fields would suggest that these stone lines were guides to the management of resources. Such a conclusion would not, however, discount the possibility that field divisions were also employed to connote ownership or tenure, perhaps in much the same way that the cultivation and improvement of land in Usambara leads to the usufruct right to cultivate (Feierman 1990: 169-185; see pp. 124-5 above). Although built by employing a very different technique, the low terrace walls that divide the cultivation area in the North and South Fields could have acted in the same way during the period of arable production.

Summary and discussion

By combining the results of the previous and recent fieldwork at Engaruka it is now possible to broadly phase the development and expansion of the site. In terms of relative chronology the following summary prioritises the recent targeted stratigraphic investigations undertaken by the current project, though the survey data produced by Sutton form the foundation of this analysis. In terms of absolute chronology the radiocarbon results remain of primary importance, though the caveats outlined above (p. 189) regarding the limited number of samples and the bias towards 'village 2' should be borne in mind. These qualifications notwithstanding, the radiocarbon samples that produce the earliest potential calibrated dates are GX-247 from stone circle C1 and M-1892 from a terrace platform in 'village 2', both of which may be as early as the late thirteenth century, but which probably fall between the late fourteenth and early sixteenth centuries (see figure 5.11). It would seem probable, therefore, that the habitation area on the lower escarpment slopes to the immediate south of the Engaruka is broadly contemporary with the stone circles, though given that the stone circle radiocarbon samples were not retrieved from within the fabric of the structures themselves it is possible that some or all of these enclosures pre-date the establishment of the hillside settlement.

More accurate dating of the circles must await the recovery of datable material from within construction contexts, and indeed until such a time as well stratified artefactual evidence can be retrieved from wall deposits, the possibility that these enclosures relate to a primarily pastoral economy cannot be discounted. However, located close to the Engaruka, the

Olemelepo and the water course referred to by Sutton (for example 1978: 52) as the 'Olemelepo artery canal', the enclosures are thereby also situated either on, or adjacent to, the relatively fertile soils of the alluvial fans (Westerberg 2002a) which are likely to have been the first areas to be exploited for arable production. Given that even self-identified 'pure-pastoralists' undertake small-scale arable cultivation where the opportunity presents itself (for example Morgan 1974; see p. 96-7 above) it is probable that this conjunction of a reliable water source and good soils would have been exploited in this early period. Indeed, despite the lack of evidence indicating the use of formal irrigation channels at the time the enclosures were first constructed, it is perfectly feasible that the community could have employed simple earth furrows like those employed by the Turkana (Morgan 1974) or, more locally, by the Sonjo (Adams Potkanski and Sutton 1994: 26-27). Conversely, the apparent relationship between several of the stone circles and the 'Olemelepo artery canal' should not be seen as definitive evidence of formal irrigation in this early period because, like the channels that would later be used in the North Fields, this watercourse was almost certainly a natural stream that was later augmented by the addition of revetments.

With five radiocarbon samples (UCLA 1615a, M-1892, M-1893, Hela-717 and Hela-722) from 'village 2' producing likely calibrated date ranges between the mid-fifteenth and late seventeenth centuries, it is clear that this settlement was well established by at least AD 1600. The suggestion that the rationale behind this location was partly motivated by a perceived need to avoid living on valuable irrigable land (for example Sutton 1978: 43) would thus seem unlikely, principally on the grounds there is no evidence that the whole of the Central, South and North Fields were cultivated at this comparatively early stage. There is thus no evidence that the community perceived land as a limiting factor at the time the first hillside settlement was established. As such, regardless as to whether the hillside location offers real advantages in terms of defence, this would nevertheless seem to have been the impetus behind the adoption of this location; a conclusion that receives circumstantial support from comparisons with Sonjo, Iraqw and Konso. It should be stressed, however, that there is no firm evidence that the community moved from the valley floor onto the hillsides. Moreover, whilst the location of the settlement may have offered some advantages in terms of defence, the establishment of a permanent habitation site would strongly suggest that the community had focussed its economy on arable production by this time, yet the relatively low-lying cultivation area exploited by this population would have remained extremely vulnerable to attack. The siege hypothesis (see p. 85 and 119 above) would thus seem inappropriate.

Throughout the early period of the occupation of 'village 2' during the fifteenth and sixteenth centuries it is probable that the Central Fields remained the focus of arable production, with the cultivated areas adjacent to the Engaruka and Olemelepo gradually expanding to include all the intervening land overlooked by the original settlement site. Despite climatic evidence indicating that this period was comparatively wet (Westerberg 2002b citing Nicholson 1998; Verschuern et al. 2000; Johnson et al. 2001; see p. 177 above) the earliest components of the irrigation system presumably date to this period. Land in this area was prepared by tillage, with cleared stones employed to revet the sides of natural streams and artificial irrigation furrows. Regrettably it is still not possible to say with any certainty at what point cleared stones were also used to act as field divisions, but these plot boundaries evidently pre-date the construction of the stone cairns; features which themselves serve as evidence for prolonged or recurrent cultivation of the Central Fields. This being so, it is probable that the use of stone for the demarcation of cultivated land does indeed date to this earlier period.

Similarly, although it is clearly somewhat speculative to place too much faith in a single radiocarbon sample, the calibrated date for Har-5476 retrieved from a terrace platform in 'village 3' would suggest that this habitation site was established at some time prior to 1700 cal AD and may have been founded as early as the late fifteenth century. Occupying land to the immediate north of the largest river in the vicinity, the decision to expand the area of habitation across the Engaruka to found 'village 3' may have been motivated primarily by the availability of a reliable water source. However, this expansion may have also coincided with the decision to intensify arable production of the North Fields area, though of course this does not mean that this land had not been exploited previously for either grazing or the growing of crops. Nevertheless, regardless of the date at which it was decided to manage the water and sediments carried by the streams in the North Fields, once made, this decision must have led to a relatively rapid expansion of the area under formal irrigation. Eventually covering over 900ha, if the process of sediment capture and terrace construction in this area began as early as the late fifteenth century and continued until the site was abandoned at a time no later than AD 1800, this would still require an expansion rate of approximately three hectares per annum. Although this expansion was incremental, and there is thus no reason to see the terraced landscape as evidence of the centralised mobilisation of labour, it would nevertheless seem reasonable to regard this process as one involving increased inputs in terms of the preparation of land. As such, the effort expended in the relatively rapid expansion of the North fields does not give the impression that this area was economically peripheral to Central Fields, or that it was merely opportunistically cultivated when heavy rains or exceptional stream-flows allowed.

Whilst admittedly somewhat circumstantial, support for this conclusion comes in the form of the radiocarbon determinations for the habitation area that overlooks these fields (Hel-4639 and Hel-4640), both of which suggest probable calibrated dates for the occupation of 'village 6' at some point after 1600 cal AD (Stuiver et al. 1998 and McCormac et al. 2004 – see figure 5.11). The habitation area is thus expanding northwards along with the field system below. Calibrating to this same period, the single radiocarbon sample from the southernmost habitation area M-1894 indicates that this settlement may also have been occupied by the early seventeenth century (Stuiver and Kra 1986; Stuiver et al. 1998; McCormac et al. 2004 – see figure 5.11), though further dates would clearly be required to corroborate this result. If indicative of 'village 1' as a whole, M-1894 would thus suggest that the occupation area expands to both the north and south during the seventeenth century, and it would thus seem likely that the construction of the South Fields is approximately contemporary with those built using similar techniques to the north of the Engaruka.

That the expansion of the habitation area does not lead to the abandonment of the earlier settlements is attested to by Hela-718, Hela-719, Hela-720 and Hela-721 which probably indicate late seventeenth to late eighteenth century occupation within 'village 2', and by Har-5475 and Har-5477 which suggest continued early seventeenth- to eighteenth-century settlement within 'village 3'. Stratigraphic evidence for expansion within the settlements comes in the form of the technique of terrace construction whereby the outer walls of pre-existing structures are employed in the building of further features, and by the results of Sassoon's excavation which appear to demonstrate that terraces are built over earlier discard deposits and even burials (Sassoon 1967: 205-6; see pp. 163-4 above). Further evidence of continued or recurrent occupation is also indicated by the sequence of deposition prior to the construction of hearth features in both 'village 2' and 'village 6' (Siiriainen et al. 2003a; see pp. 180-1 above).

By the late seventeenth or early eighteenth century, therefore, terraces within the whole of the habitation area are occupied, though the excavation of structures within these areas that appear to have been re-used as refuse dumps (Robertshaw 1986: 7; see p. 171) demonstrates that not all of the platforms were occupied at any given time. The construction of both the North and South fields must have been well underway by this period, whilst the calibrated date for carbon sample Hela-716 would suggest that the stone circles remained in use, and indeed the process of sub-dividing them into small arable plots may have already taken place. Since survey work by Sutton (for example 1978: 50-4) demonstrates that many of the furrows within the Central Fields area can be traced to 'artery canals' it is evident that these large irrigation features were first constructed either shortly before or during the period in which this area was first cleared, sub-divided and cultivated. However, it is clear that several of the large embanked furrows in the Central Field area overlie earlier field divisions, and there is the suggestion – as yet untested by excavation – that in places their construction may have been followed by modification to the surrounding fields (Sutton 2000 [1998]: 10; 1999: 80; 2004: 122). These features are therefore evidently relatively late within the development of the site, with the embanked section of the 'great northern canal' indicating that this feature was probably built after the construction of at least the most southerly of the terraces in the North Fields. These 'embanked furrows' thus represent good evidence of hydrological decline within the smaller watercourses at a comparatively late stage of the site's development (ibid.); a conclusion that receives support from the recognition of furrow off-takes leading from the now almost permanently dry 'intermediate north gorge' (Sutton 2000 [1998]: 11; 1999: 81-2; 2004: 120-2), and from the results of the excavation in the North Fields undertaken by the current project, which demonstrate that at the time in which these terraces were constructed this area was dissected by numerous watercourses that contained water flows sufficient to entrain fine sediments, and to deposit coarse gravels and stones against the lower courses of their revetted sides. The identification of a simple stone line that was built after one of these North Field channels had gone out of use would seem to indicate that this area continued to be farmed, though at present it is unknown whether this late period employed water supplied by the comparatively late 'great north canal', or indeed whether irrigation was used at this stage at all.

Either way, hydrological decline would seem to have been a major contributory factor in the decision to completely abandon the site, though there must have been an unknown social dimension to this decision since there remains sufficient water within the Engaruka to support the modern population. Although several of the calibrated radiocarbon samples would indicate that it is possible that occupation continued into the nineteenth century, the lack of oral historical references to the community by the time of European contact would tend to argue against it. It would thus seem reasonable to conclude that the site must have been comprehensively abandoned at some time prior to AD 1800, by which time the Maasai were well established within the region (Galaty 1993; Lamprey and Waller 1990; Sutton 1978, 1990 and 1993). Although not a hypothesis favoured by the current population of Engaruka, the possibility that the arrival of the Maasai also contributed to the abandonment of the site cannot be discounted, and indeed the Maasai Elders consulted by Leakey in 1936 supported this conclusion (see also Sutton 1978: 66).

The management and sustainability of the economy at Engaruka

With the exception of its emphasis on the relative chronological development of the site, the above summary of the archaeological evidence from Engaruka is not radically different from earlier synopses. Yet even relatively minor revisions affect the interpretation of the site and therefore how it is seen as an example of African indigenous agriculture. Thus, just as the conclusion that the community was isolated and introverted relied partially upon the interpretation of the cairns and stone circles as late defensive structures (Sutton 1978), so the belief that the stone circles were late stock enclosures built to accumulate manure added weight to the hypothesis that several centuries of continuous cultivation had led to soil degradation (for example Sutton 1984 and 1986). The recognition that the stone circles relate to an early phase of occupation casts doubt on such a conclusion and, by extension, also questions Koponen's (1988: 383) appraisal (and assumption) that the site represents an example of an economic "cul-de-sac" brought about through the mismanagement of resources.

In effect this last point is little more than a warning against drawing conclusions on the basis of incomplete evidence, and clearly such a warning applies as much to the current project as it does to any other. Indeed, if the results presented above prove anything definitively it is that considerably more work would be required to fully understand the site. However, by focussing on the chronological development of the various features at Engaruka the intention has been to highlight the importance of this temporal dimension and to demonstrate the need to direct further research towards achieving a more complete understanding of how this and other examples of African agriculture have changed through time. As was briefly touched upon above when discussing assumptions regarding the labour requirement of 'landesque capital' (p. 80), the importance of this temporal element has been highlighted by previous archaeological studies which have subsequently been employed to challenge Wittfogel's (1957) assertion that large scale irrigation systems require pronounced social hierarchies capable of mobilising labour. In particular, the centralised labour hypothesis was questioned by Woodbury (1960, cited by Howard 1993) who argued that the extensive irrigation system developed by the Hohokam in Arizona USA between approximately the seventh and fifteenth centuries AD, could have been built incrementally by periodically extending the canals. Although this model of "accretionary growth" has since been critiqued on the grounds that it did not question the lifetime or maintenance requirements of canals, and did not consider the hydrological problems of extending relatively short water channels for distances of up to 25km (Howard 1993: 269), Woodbury's basic premise remains valid in so far as it emphasises the dangers of assuming that the physical remains of an agricultural system were all constructed in a single phase. Soper's (1996, 2000, 2002; see p. 117 above) work at Nyanga serves to make much the same point by demonstrating that a relatively small population could have produced extensive areas of terracing, as does – more modestly – the work reported upon here, since it is clear that much of the terraced and irrigated area at Engaruka was built by repeating a tried and tested method of construction.

Whilst this ability to examine the development of agronomies diachronically is the principal strength of the archaeological method and thus represents the most obvious area in which archaeology can make a contribution to the study of indigenous agriculture, the examination of the soils within abandoned field systems produces what are essentially synchronic results, since they permit an appraisal of the state of these soils at the point at which agricultural production ceased. Nevertheless, the ability to examine the effects of production on soils within abandoned agronomies still represents an opportunity that is not available in occupied areas where it may be impossible to separate the effects of recent cultivation from the consequences of past practices (Homburg 2002). Moreover, the chemical composition of soils offer potentially important insights regarding the sustainability of abandoned agronomies, and it is for this reason that the small set of soil samples collected by the current project were taken.

The analysis of an initial set of just 11 samples taken from fields, furrows and stone circles within the Central Fields, and from habitation terraces within 'village 3' seemed to show a correlation between feature type and the availability of primary and secondary nutrients, whilst comparisons with recently cultivated and uncultivated controls suggested tentatively that the soils within the Central Fields had suffered from nutrient depletion (Stump 2003). A further set of samples were thus taken to include fields and furrows within the North and South Fields, and to increase the number of samples relating to the central Fields and the stone circles. The number of controls were also increased to include five samples from currently cultivated and irrigated fields within the modern village of Engaruka Juu, as well as two sets of five samples from areas adjacent to steams on and above the alluvial fan of the seasonal Mboko river located approximately 9km to the south of Engaruka. Totalling just 62 samples, it should be reiterated that the soil analyses undertaken by the current project must be seen as representing a very preliminary examination. Nevertheless, the sample set does cover the principal feature types on the site and includes at least 10 samples each from the North, South and Central Fields. It is thus possible to draw some preliminary conclusions and to identify trends that can be reasonably linked to differences in the way the various field areas were constructed and farmed.

Figure 5.45: Soil sample results 2001-2003 (continued below)

Lab ID	Sample No.	Location 2003 unless stated	pH in water	Exchangeable Calcium (me/100g soil)	Exchangeable Magnesium (me/100g soil)	Exchangeable Potassium (me/100g soil)	Extractable Phosphorus (mg P/kg)	Organic Carbon (%)	Total Nitrogen (%)	C:N ratio	Total Phosphorous (%)
1153-1	1	2001 Stone circle	7.9	11.2	3.7	2.51	61.5	1.44	0.142	10.14:1	0.349
1153-2	2	2001 Furrow Central Fields	7.3	10.0	3.1	1.57	51.4	1.42	0.137	10.36:1	0.369
1153-3	3	2001 Field by Furrows Central Fields	7.6	9.1	3.2	1.40	42.2	0.80	0.057	14:1	0.390
1153-4	4	2001 Field Central Fields	7.4	6.9	2.3	0.97	34.6	0.85	0.053	16:1	0.403
1153-5	5	2001 Field by stone circle	7.7	7.3	1.9	0.94	55.9	0.96	0.044	21.8:1	0.356
1153-6	6	2001 House platform Hillside/village 3	8.1	17.2	4.2	2.24	162.6	2.06	0.205	10.04:1	0.787
1153-7	7	2001 House platform Hillside/village 3	8.2	19.6	4.1	2.92	170.8	2.51	0.347	7.23:1	1.197
1153-8	8	2001 ?Garden terrace Hillside/village 3	8.3	18.3	3.5	2.47	117.7	2.10	0.265	7.92:1	0.642
1153-9	9	2001 River bank S of Hillside/village 3	7.8	9.7	3.9	1.05	26.7	1.07	0.082	13:1	0.215
1153-10	10	2001 Modern field, recently cropped	7.7	10.4	3.3	1.39	30.5	1.18	0.081	14.56:1	0.220
1153-11	11	2001 Uncultivated bush	8.2	15.6	2.5	1.67	37.3	1.17	0.125	9.36:1	0.440
3348	13	2002 Upper 'fill' of stone circle room A	8.81			Contaminated during analysis					---
3349	14	2002 Lower 'fill' of stone circle room A	7.88	13.6	3.6	3.81	47.9	1.76	0.178	9.89:1	---
3351	16	2002 Upper 'fill' of stone circle room B	7.73	13.7	2.8	2.79	17.3	1.43	0.148	9.66:1	---
3352	17	2002 Lower 'fill' of Stone circle room B	7.78	13.1	3.5	3.21	30.7	1.69	0.153	11.05:1	---
3353	18	2002 Field by stone circle	8.66	12.1	3.4	3.76	9	1.49	0.09	16.56:1	---
3354	24	2002 hearth fill Hillside/village 2	8.37	15	6.4	6.1	246.5	2.31	0.198	11.67:1	---
3355	30	(316): upper 'fill' of Stone circle	6.77	10	2.2	1.38	21.5	1.19	0.045	26.44:1	---
3357	32	Furrow fill (406), North Fields	8.23	11.6	2.2	2.31	2.6	0.62	0.067	9.25:1	---
3358	33	Furrow fill (411), North Fields	7.88	9.2	2.1	0.94	6	0.84	0.066	12.72:1	---
3359	34	Terrace, North Fields, adjacent to <35>	8.58	14.1	3.1	1.3	4.1	0.81	0.092	8.8:1	---
3360	35	Terrace deposit (324), adjacent to <36>	8.42	14.5	2.4	2.53	5.9	0.83	0.097	8.56:1	---
3361	36	Terrace deposit (326), adjacent to <37>	8.34	13.6	1.9	1.76	3.5	0.84	0.078	10.77:1	---
3362	37	Terrace deposit (328), adjacent to <33>	8.52	13.9	1.8	2.04	3.1	0.68	0.075	9.07:1	---
3363	38	Terrace, North Fields, adjacent to <32>	8.18	13.6	2	3.36	5.2	0.72	0.09	8:1	---
3364	39	Terrace, North Fields, adjacent to <38>	8.17	17.6	2.8	3.64	5.6	0.87	0.116	7.5:1	---
3365	40	Terrace, North Fields, adjacent to <39>	8.34	12.4	1.9	2.99	7.6	0.62	0.077	8.05:1	---
3366	41	Terrace, North Fields, adjacent to <40>	8.32	15.2	2.5	3.56	5.2	0.62	0.075	8.27:1	---
3367	42	Furrow, South Fields	8.15	12.2	2.3	1.7	7.9	1.56	0.092	16.97:1	---
3368	43	Terrace, South Fields, adjacent to <42.	7.87	10.8	2.2	2.62	13.4	1.23	0.078	15.77:1	---
3369	44	Terrace, South Fields, adjacent to <43>	8.01	11.1	2.1	3.4	7.9	1.32	0.096	13.75:1	---
3370	45	Terrace, South Fields, adjacent to <44>	7.97	11.3	2	3.67	17.8	1.51	0.09	16.78:1	---
3371	46	Terrace, South Fields, adjacent to <45>	7.77	10.3	2.1	2.31	12.9	1.72	0.075	22.93:1	---
3372	47	Furrow, South Fields	8.34	9.5	1.6	2.94	24	0.67	0.049	13.67:1	---
3373	48	Terrace, South Fields, adjacent to <47>	8.31	13	2.1	2.68	18.2	1.31	0.11	11.9:1	---
3374	49	Terrace, South Fields, adjacent to <48>	8.39	14.5	2.2	2.63	8.6	1.12	0.073	15.34:1	---
3375	50	Terrace, South Fields, adjacent to <49>	8.34	11.3	1.8	2.77	11.6	1.4	0.071	19.72:1	---
3376	51	Terrace, South Fields, adjacent to <50>	8.33	12.1	1.9	2.44	6.5	1.42	0.069	20.58:1	---

Figure 5.45: Soil sample results 2001-2003

Lab ID	Sample No.	Location 2003	pH in water	Exchangeable Calcium (me/100g soil)	Exchangeable Magnesium (me/100g soil)	Exchangeable Potassium (me/100g soil)	Extractable Phosphorus (mg P/kg)	Organic carbon (%)	Total nitrogen (%)	C:N ratio
3377	52	Stream base, Mboko alluvial fan	7.77	8.5	1.9	1.43	37.1	1.62	0.12	13.5
3378	53	Uncultivated, Mboko alluvial fan	7.83	7.7	1.8	2	91.6	1.68	0.065	25.85:1
3379	54	Uncultivated, Mboko alluvial fan	7.96	10.9	1.4	2.64	111.9	2.01	0.193	10.42:1
3380	55	Uncultivated, Mboko alluvial fan	7.83	6.1	1.5	1.4	84	0.92	0.024	38.33:1
3381	56	Uncultivated, Mboko alluvial fan	7.84	5.1	1.6	1.66	69.4	1.04	0.017	61.18:1
3382	57	Stream base above Mboko alluvial fan	7.94	17.5	1.4	5.08	4.1	0.12	0.028	4.29:1
3383	58	Uncultivated, adjacent to <57>	8.45	26.3	2.6	5.1	4.3	0.53	0.067	7.91:1
3384	59	Uncultivated, adjacent to <58>	7.78	24.4	2.7	5.54	7.3	0.73	0.09	8.11:1
3385	60	Uncultivated, adjacent to <59>	8.14	20.1	2.2	5.53	9.7	0.62	0.084	7.3:1
3386	61	Uncultivated, adjacent to <60>	8	21.9	2.5	4.35	10.6	0.89	0.125	7.12:1
3387	62	Base of modern furrow	8.08	7.4	2.6	0.98	18.5	1.37	0.03	45.67:1
3388	63	Modern field planted with maize	7.98	8.6	2.5	2.05	35.2	1.59	0.14	11.36:1
3389	64	Modern field, adjacent to furrow, maize stunted	8.02	7.4	2.1	1.33	49.3	1.32	0.052	25.38:1
3390	65	Modern field, planted with potatoes	7.64	11	3	2.57	61.7	2.79	0.27	10.33:1
3391	66	Modern field, uncultivated, recently manured	8.75	8.2	2.3	7.89	282.1	2.8	0.311	9:1
3392	67	Furrow, Central Fields	8.1	9.7	2.1	1.79	43.2	0.54	0.066	8.18:1
3393	68	Field, Central Fields, adjacent to <67>	7.9	9.5	1.9	1.67	36	1.1	0.081	13.58:1
3394	69	Field, Central Fields, adjacent to <68>	7.89	9	2.7	1.08	74.9	0.82	0.06	13.67:1
3395	70	Field, Central Fields, adjacent to <69>	8.08	12	3	2.76	33.8	0.84	0.095	8.84:1
3396	71	Field, Central Fields, adjacent to <70>	8.2	14.2	3.3	2.59	25.8	1.02	0.119	8.57:1
3397	72	Furrow, Central Fields	7.78	9.1	2.3	2.44	12.2	1.21	0.056	21.6:1
3398	73	Terrace, Central Fields, adjacent to <72>	7.57	7.5	2.5	2.15	25	1.54	0.041	37.56:1
3399	74	Terrace Central Fields, adjacent to <73>	7.88	8.8	2.2	2.14	19.2	1.21	0.045	26.89:1
3400	75	Terrace, Central Fields, adjacent to <74>	7.42	8.6	2.1	2.79	15.6	1.22	0.049	24.9:1
3401	76	Terrace, Central Fields, adjacent to <75>	7.31	8.9	2.1	2.12	17.6	1.95	0.103	18.93:1

Analysis	Units	Comment (Kubasu pers. comm.)
pH in water		Soil:Water ratio = 1:2.5, de-ionised water
Exchangeable Calcium	me/100g	Units equivalent to cmol$_c$/kg. 10:1 solution:soil ratio, 1N KCl extraction, analysis by NaOH titration
Exchangeable Magnesium	me/100g	Units equivalent to cmol$_c$/kg. 10:1 solution:soil ratio, 1N KCl extraction, analysis by NaOH titration
Exchangeable Potassium	me/100g	Units equivalent to cmol$_c$/kg. 10:1 soil:solution ratio, 0.5 M NaHCO3 + 0.01 M EDTA, pH 8.5 (modified Olsen), analysis by flame photometer
extractable phosphorus	mg P/kg	10:1 soil:solution ratio, 0.5 M NaHCO3 + 0.01 M EDTA, pH 8.5 (modified Olsen), analysed colorimetrically by molybdenum blue method
Total soil organic carbon	%	Multiply by 10 to convert to g/kg. H2SO4-dichromate oxidation at 150 C (modified Mebius method), colorimetric determination.
Total nitrogen	%	Multiply by 10 to convert to g/kg
Total phosphorus	%	Multiply by 10 to convert to g/kg

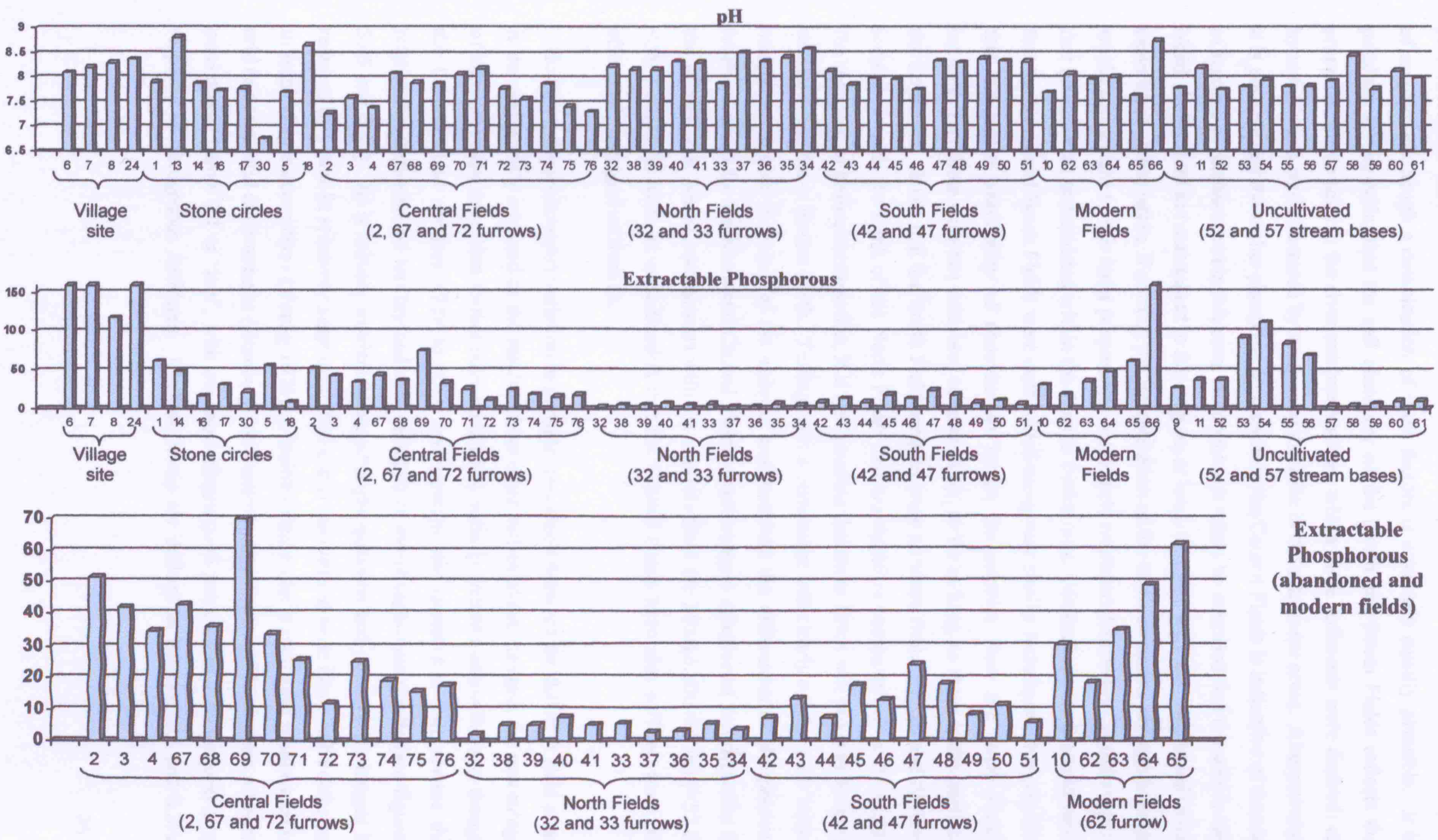
Of the analyses listed in figure 5.45 the two that are most useful in reconstructing the effects of the pre-colonial agronomy are soil reaction (pH) and phosphorous levels, the former of which is "regarded by some as the most useful single analytical test for predicting crop response" (Young 1976: 94) and can be employed to examine the possibility that a prolonged period of irrigation led to excessive salination or to the accumulation of alkalis through the evaporation of water. Since phosphorous usually occurs as a very stable compound and is only available to plants in the form of phosphate, high levels of very insoluble phosphorous compounds (usually fixed with iron or aluminium) will accumulate in stock-keeping compounds or habitation areas, as well as in locations where fertiliser has been applied or where soils have been improved by the addition of burnt material. It is thus "an especially useful indicator of ancient cultivation effects" (Homburg and Sandor n.d.: 8).

All of the samples taken in 2002 and 2003 produced soil reactions in the alkaline range. In very general terms this would indicate that the soils within the former cultivation areas are comparatively fertile as all of the primary and the majority of secondary nutrients are at maximum availability within the soil reaction range of pH 6 to pH 7.5 (Young 1976), though the range for nitrogen extends to pH 8 (Homburg and Sandor n.d. citing Foth and Ellis 1988), whilst a pH of between 6 and 6.5 provides the optimum conditions for the availability of phosphorus (ibid. citing Tisdale et al. 1985). However, sorghum, the only crop for which there is available evidence for exploitation at Engaruka, has a preference for soil reaction in the range pH 5.5-6.5 with a tolerance of pHs from 5-8 (Young 1976). Many of the soils examined by the current project thus exceed the ranges of maximum nutrient availability and for sorghum's tolerance of alkalinity, though it should be noted that the crop is known to have an acidifying effect and indeed "within one season [of planting sorghum] it is not uncommon for the alkalinity to drop a full pH unit and the calcium solubility to increase tenfold" (BOSTID 1996: 203). Nevertheless, although the 11 samples taken by the pilot study suggested that the pH of soils within the former cultivation areas were lower than those of the controls, the larger sample set does not support this conclusion since the two groups of samples from excavated furrows and associated terraces in the North Fields (samples <32> to <41>), and samples <47> to <51> from a furrow and nearby terraces in the South Fields, produced higher pH determinations than the majority of the samples from either the uncultivated areas or from modern fields (see figure 5.46). Moreover, with the exception of samples <13> and <18> which are associated with stone circles, the soil reaction results from the North and South Fields are generally higher than those recorded for the central fields. It is possible, therefore, that the North and South Fields have increased pH levels as a consequence of prolonged irrigation or as a result of the technique of construction which would seem to have involved channeling water onto the field area. Alternatively, it is possible that the alluvial sediments that were captured during the construction of these fields were themselves more alkaline than those exploited in the Central Fields area.

As with the soil reaction results, tentative conclusions based on phosphorous levels from the original 11 samples require some qualification when seen in the context of the larger sample-set taken in 2002 and 2003. In particular the comparatively high phosphate levels recorded from areas within or adjacent to stone circles (samples <1> and <5>) were seen as offering provisional support to the suggestion that these features represented stock enclosures. Whilst the additional samples do not refute this interpretation – and indeed sample <14> from the lower layer within Siiriäinen et al.'s 'stone circle room A' appears to conform to this trend – the samples from 'room B' (<16> and <17>) show phosphate levels comparable with the other samples from the Central Fields, whilst sample <18> from a field to the immediate east of this enclosure seems anomalously low when compared with other phosphate determinations from the central area. It might be concluded, therefore, that this second structure performed some other function such as a house or shelter for those tending the stock, though to do so is no doubt somewhat speculative at this stage. Nevertheless, with Young (1976) defining available phosphorous levels between 10-40 mg P/kg (or ppm) as 'medium' and those above 40 as 'high', samples <1> and <14> from the centres of stone circles are well above the threshold to be classified as high, as are samples <2>, <3>, <67> and <69> from furrows and fields within the central area. With the exception of <18>, all of the other samples from the Central Fields would be classified as medium (see figures 5.45 and 5.46).

In contrast, the ten samples from the North Fields would all be considered as having either 'low' or merely 'sufficient' levels of extractable phosphorous under the definitions offered by Homburg and Sandor (n.d.: 13 citing Doerge 1985) who consider levels below 2mg P/kg (or 2 ppm) as low and values above 5mg P/kg as sufficient. Under this definition four of the South Field samples would also be regarded merely as adequate, with the remainder containing medium levels of available phosphorous. The closest parallels to the North Fields samples are therefore the five controls (<57> to <61>) taken from the escarpment immediately above the Mboko alluvial fan; an area that is used solely as occasional grazing land for small stock. As a primary nutrient which if deficient restricts root growth (Young 1976), the low levels of available phosphorous within the North Fields would indicate that this area is agriculturally marginal and would thus require applications of fertiliser in order to be exploited for arable production.

Figure 5.46: pH and extractable Phosphorous by sample

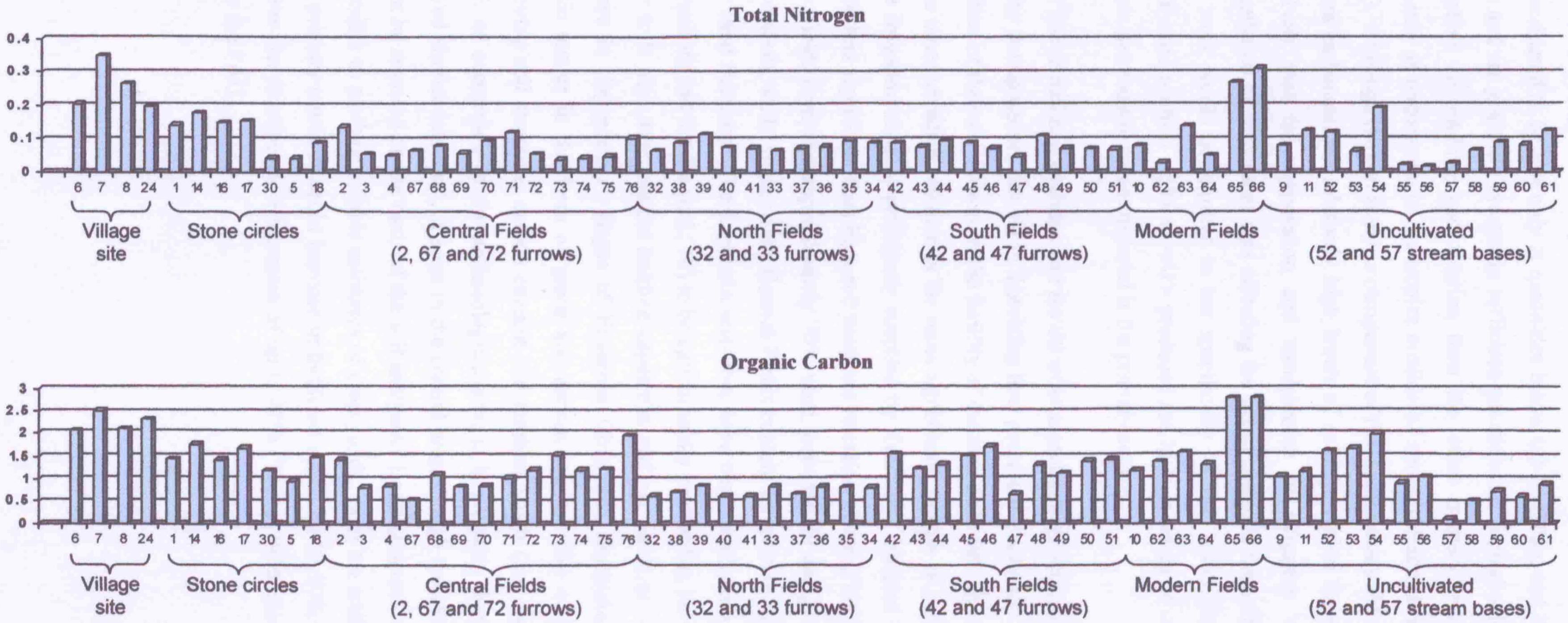


Although it is not possible at present to interpret the marked difference between the phosphorous results for the North and Central Fields with any certainty, the explanation presumably lies with either the different methods of construction or with different techniques of cultivation, though a combination of these factors is obviously equally plausible. It is possible, for example, that the soil chemistry of the North and South Fields reflects the properties of the soils in the river catchments from which these sediments were derived; an hypothesis that could be tested by examining the soils in the catchment areas. Alternatively, it is possible that the higher phosphate levels within the Central Fields is indicative of the use of manure as fertiliser within this area, from which it might be surmised that the soils in the North Fields were not maintained in this way or, at least, that they were not maintained to the same level. Once again, if correct, the interpretation of the stone circles as stallage features would add weight to this latter proposition, since their restricted distribution would suggest that manure was accumulated within the Central Fields area. Similarly, since it would seem that the North and South Fields were constructed using very similar techniques, it is possible that the higher availability of phosphorous within the samples from the South Fields indicates that these were not cultivated as intensively, or for as long, as those to the north of the Engaruka. Given that the North Field samples were all taken from terraces and furrows located towards the south of the North Fields and are therefore comparatively early within the sequence of terrace construction, it is also possible that these fields will prove to be more depleted than those further north. Testing such a contention will clearly require a far larger sample set, but on the basis of the samples analysed here the differences in phosphorous levels recorded for the North and Central Fields would suggest a degree of soil depletion in the former area, whilst comparisons with the controls from the Mboko alluvial fan (<52 to <56>) might be taken as an indication that the Central Fields have also suffered from the effects of prolonged cultivation.

However, the pronounced variation in phosphorous levels between the different field areas is not consistently mirrored in the results of the other soil analyses. Indeed, the percentage of nitrogen in the soils from former cultivation areas is fairly constant across the site, though the Central Field samples <72> to <76> are amongst the lowest and thus reverse the relationship between soil fertility and area reflected in the phosphorous results (see figures 5.45 and 5.47). As a primary nutrient along with phosphorous and potassium, nitrogen is required by plants in relatively large quantities and is the nutrient most likely to be deficient in tropical agro-ecosystems (Young 1976); a limiting factor that is particular pronounced in arid and semi-arid environments (Homburg and Sandor n.d.). Young (1976) defines nitrogen percentages below 0.1 as ‘low’, with correspondingly good potential of a preferential crop response to nitrogenous fertilisers. Medium levels are defined as between 0.1 and 0.2%, whereas high levels with improbable fertiliser response are those greater than 0.2%. However, nitrogen derived from organic matter is unavailable to plants until it has first been mineralised by micro-organisms or fungi to either nitrate or ammonia. Of these two forms, nitrate is the one most commonly absorbed by plants but it is also highly soluble and is thus easily lost through leaching (Young 1976); an effect that is apparently evidenced in sample <64> were maize planted on sloping land adjacent to a furrow was noticeable stunted when compared to the irrigated maize growing on level land just 5m away. This problem with irrigating on a slope was recognised by the landowner who commented that terraces 'slowed water down' thus preventing it from 'harming' the soil (Madaha, interview 31st October 2003); a comment that reiterated the view expressed by several local farmers during a visit to the excavation area in the North Fields (interviews 24th October 2003). In modern Engaruka, as elsewhere, the problem of nitrate loss through leaching is generally counteracted by repeated applications of fertilisers throughout the growing cycle, though nitrogen levels can also be increased or maintained by rotation with nitrogen fixing plants such as legumes, or by leaving cultivation areas fallow.

Since the level of organic carbon in soil gives a good indication of the level of organic matter, the ratio of carbon to nitrogen provides an index to the degree of nitrogen mineralisation (Young 1976 and Homburg and Sandor n.d.). High ratios indicate that much of the total nitrogen is in a form unavailable as plant nutrient. Homburg and Sandor (n.d.: 8) cite ratios of between 8:1 and 15:1 as usual for agricultural soils, whilst Young offers a narrower range of between 10:1 and 12:1, with figures higher than this being seen as indicative of inhibited nitrification. The level of organic carbon in a soil is itself seen as an index of the overall level of organic matter. Citing Young (1982), Homburg and Sandor note that topsoils with >3% organic matter consistently produce the highest yields. Under these definitions the majority of the samples taken from former cultivation areas at Engaruka would be regarded as having low levels of nitrogen and low levels of organic carbon. Similarly, employing the figures for preferential carbon:nitrogen ratios suggested by Young would indicate that in many of the former field areas the organic carbon within these soils is at an early stage of decomposition and is thus unavailable to plants. Indeed, even if the slightly broader range preferred by Homburg and Sandor (n.d.: 8) is used, only 29 of the 41 samples taken from stone circles, furrows and fields do not produce ratios indicative of inhibited nitrification. As such, the combined nitrogen and organic carbon sample results demonstrate that the field areas exploited by the precolonial community at Engaruka would now require additional sources of nitrogen and organic matter in order to be agriculturally productive.

Figure 5.47: Total Nitrogen and organic Carbon by sample



Like the nitrogen analyses, the tests for potassium, calcium and magnesium are all best seen as giving an indication of the current potential of the soils at Engaruka, rather than as a means of assessing the consequences of precolonial cultivation. All three of these nutrients are considered to be low only at quantities below 0.2 me/100g, and high above 0.4 (Young 1976) and are generally present in sufficient quantities in tropical soils, with potassium less susceptible to leaching and fixation than the other primary nutrients, whilst calcium deficiency is uncommon in the tropics outside of strongly leached rainforest environments (ibid.). Although the soil analysis component of the current study did not specifically test for calcium carbonate, the relatively high levels of calcium within the samples might suggest tentatively that the evaporation and transpiration of irrigation water has led to the accumulation of carbonates thus effecting the pH of the soils from field areas. Once again, more work would be required to test specifically for this effect, though the fact that the uncultivated controls <58> to <61> produced the highest levels of calcium would seem to indicate that the soil parent material is the primary source.

The above outlined analyses and results offer a preliminary indication of soil fertility and thus, by extrapolation, can aid in theorising how precolonial activities may have affected the condition of the soil. However, the fertility of the area does not rely on soil condition alone. Of the other variables, climate is the most significant, though in an area such as Engaruka where irrigation water is principally supplied by rivers and seasonal streams, rainfall levels may be less significant than high soil moisture retention (Young 1976). Soil textures in the North Fields comprise approximately 70% sand, between 20 and 25% clay and between 5 and 10% silt, whilst those in the Central Fields contain up to 30% clay and correspondingly lower sand fractions. The Engaruka soils thus have clay constituents that are considered to by Homburg and Sandor (n.d.: 14) to be agriculturally productive, but the weakly aggregated sandy soils have low nutrient-holding capacities and are prone to wind erosion (ibid.: 9). Farmers in the modern villages of Engaruka Chini and Engaruka Juu thus incorporate organic matter in the form of green and animal manure into cultivation areas, thereby improving soil structure, carbon content and nutrient levels (see figure 5.48). Given the length of occupation of the archaeological site, it is probable that the abandoned fields received similar treatment, at least in the central area, though the extent of soil fertilisation cannot be assessed on the basis of the soil analyses. Lacking access to this information it is impossible to produce reliable estimates of crop yields, since the addition of just one of the three primary nutrients could increase unfertilised yields by 10-20%, whilst the addition of all three can produce yield increases of up to 40% (Young 1976 citing experiments carried out by the FAO).

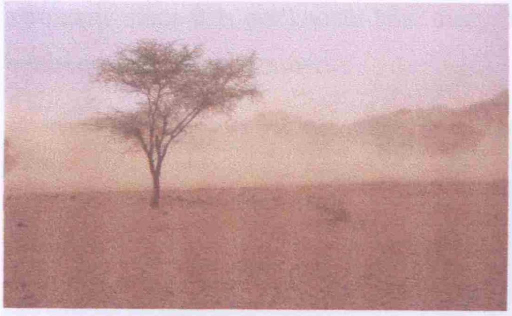
 

Figure 5.48: Uncultivated and cultivated fields to the south of the Olemelepo. The areas above are less than 100m apart and are both shown in the south west corner of the satellite image extract in figure 5.37. Both photographs were taken on the same day.

Lack of information regarding other management practices produces similar and equally significant problems. Although the detailed excavation of water channels and furrows within the North Fields permits an attempt to reconstruct flow and discharge rates for these features via the Manning equation[16] (Manning 1889 cited in Wilson 1990: 339), reconstructions of this sort are heavily reliant on data extrapolated from ethnographic analogies. Thus, unless there is archaeological evidence indicating the height of water flow within a given channel, figures for the wetted perimeter (see footnote) may have to be estimated; a problem recognised by Sutton (1986: 35-6) who observes that although the stone revetted sides of irrigation features at Konso may be up to one metre high and two metres apart, water flows within these channels were rarely more than 20cm deep and one metre across (see also figure 5.49 below). The detailed excavation results presented above help narrow this margin of error since differences in the heights of the channel and furrow bases demonstrate the minimum water levels required to feed the furrow off-takes, whilst the examination of the relationship between the channel and associated terraces illustrates the flow levels necessary to deliver water and sediments onto the field area. However, these figures remain merely minimum levels and, moreover, minimum levels for the features in full spate. This information thus remains relatively unhelpful in terms of modelling the operation of the

[16] $V = \frac{(R^{2/3} \times S^{1/2})}{n}$

V = velocity

R = hydraulic radius based on channel cross sectional area (A) divided by wetted perimeter (WP).

S = slope or gradient: fall divided by horizontal distance.

n = Manning number or roughness coefficient. For example, water velocity for the excavated channels at Engaruka could be calculated using n = 0.021: "Rough-dressed stone paved, without sharp bends" (Manning 1889 cited in Wilson 1990: 339). A Manning number of 0.03 for smooth sediment stream beds with occasional stones would seem appropriate for the furrows (following Ciolek-Torrello, Homburg and Van West 1999: 278 citing Howard 1993, Howard and Huckleberry 1991 and Katzer 1989). Note, however, that Adams (1986: 50) suggests the possibility that irrigation features at Engaruka may have been lined with mud and possibly also living grass. Although there was no evidence of such a layer sealed beneath the basal alluvial gravels in the excavated sections, a simple addition of this sort would alter the roughness coefficient and thus affect calculations of flow velocity and discharge.

Discharge is calculated using the formula: D = A x V.

agronomy since it is not known how many days, weeks or months a year in which these minimum levels were reached.

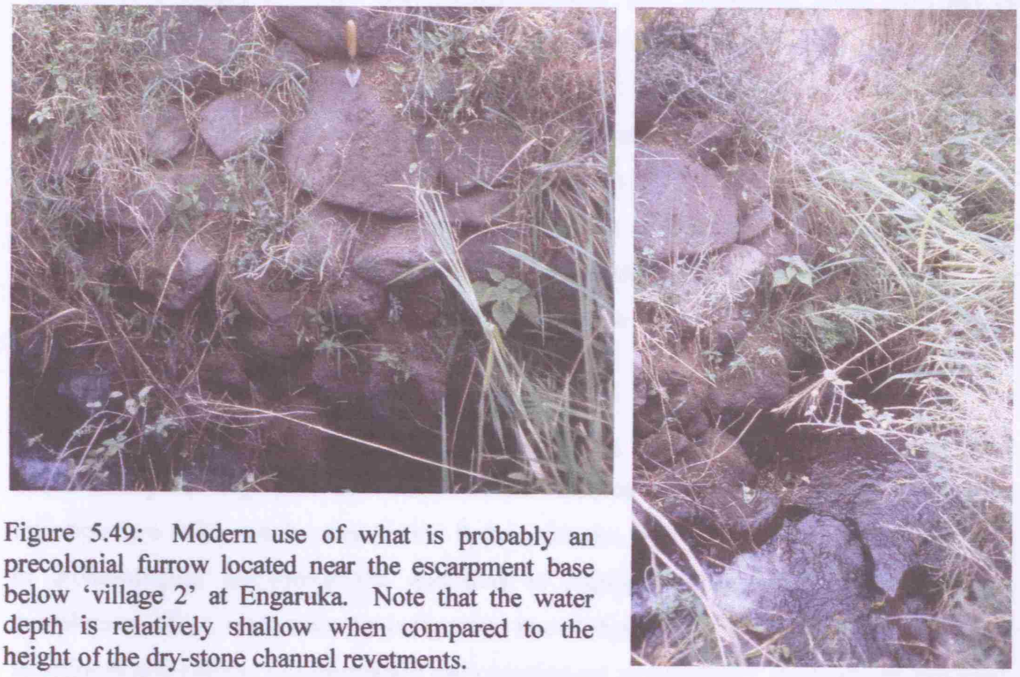


Figure 5.49: Modern use of what is probably an precolonial furrow located near the escarpment base below 'village 2' at Engaruka. Note that the water depth is relatively shallow when compared to the height of the dry-stone channel revetments.

Exacerbating this problem still further, comparisons with contemporary irrigation using communities in east African would support the impression given by the interconnected network of furrows at Engaruka that there was probably never sufficient water within the system to allow large areas to be irrigated simultaneously. A complex system of water allocation like those employed at Sonjo (Adams, Potkanski and Sutton 1993; Gray 1963), in North Pare (Sheridan 2002), or indeed like that in modern Engaruka, would therefore almost certainly have existed, and it is thus also possible that this system was integrated within archaeologically unknowable social hierarchies or religious frameworks (see chapter 2 and chapter 4 particularly pp. 131-5). More prosaically, since fallowed fields would clearly not be irrigated, and because water is an obvious factor in calculating potential crop yields, an inability to define the systems by which resources were allocated and maintained represents a serious limitation in terms of archaeological reconstruction.

Similarly, though perhaps not representing such an insurmountable barrier, the current lack of knowledge regarding the crop repertoire employed at Engaruka also restricts what can be said about the operation of the agronomy. In some respects, however, this last point is a reflection of the work still to be done, since although research at the site has thus far produced very limited direct evidence of cultivated crops in the form of macro-fossils, work targeted towards the recovery of micro-botanical remains such as pollen and phytoliths has yet to be undertaken. Forthcoming work by Westerberg (pers. comm.) will hopefully begin to redress this imbalance, and of course it remains possible that sources of macro-botanical remains have simply not been found either because crop processing areas have not be located, or because the crops cultivated were not processed or stored in ways that might lead to them being preserved in the archaeological record (Young and Thompson 1999: 68). Nevertheless, whilst comparisons with other better documented African agronomies would suggest that it is extremely unlikely that the economy at Engaruka was based solely on the production of sorghum, these same sources would also suggest that the community would probably have employed complex systems of crop rotation and inter-planting, and are also likely to have developed crop variants uniquely suited to the community's requirements (see pp. 141-5).

These last points notwithstanding, by highlighting the limitations of archaeological enquiries in producing reconstructions of former resource exploitation strategies, it is not the intention here to be unduly pessimistic. Rather, the aim is to emphasise where the strengths of archaeological knowledge lie, and thus to highlight those areas in which it can complement other approaches to indigenous knowledge, and hence also how these other techniques and sources of information can complement archaeology. As might be expected, the discipline's strengths include its obvious ability to examine the historical development of times or places that are not recorded by either written or oral sources. However, as the results presented above demonstrate, it is also possible to employ stratigraphic techniques to aid in the definition of how resources were exploited, and to exploit the opportunities provided by abandoned cultivation areas to examine the long-term consequences of agricultural production.

6

Conclusion: the feasibility of an applied agricultural archaeology in east Africa

> Agriculture is an earthy pursuit, and therefore any study of its history, whether ancient or modern, has to be down to earth, and must involve an archaeological approach.
>
> (Sutton 1991: 28)

> However, the archaeological remains of the landscape, including the settlement sites, are only the material manifestation of a whole agricultural and social system, one in which the former rural community, its livestock, crops, husbandry practices and their social context are not immediately apparent.
>
> (Soper 2002: 22)

Conceptions of African agriculture rely on an historical dimension that is all too often ignored, imprecisely understood, or presumed to be somehow self-evident. Yet ignorance of this historical detail has not stopped the production of narratives which present African environments as 'pristine', 'virgin' or 'natural', even where these areas have been employed for either expansive pastoralism or recurrent arable cultivation (for example Anderson and Grove 1987; Fairhead and Leach 1994, 1996a and b). Conversely, in those areas where the level of landscape modification clearly indicates that they have been subject to prolonged periods of permanent or recurrent cultivation, it has also been argued that continued occupation either cannot be, or must be, sustainable; the assumed longevity of production being taken as evidence of either immanent systemic collapse, or as proof of the management skills of the local population (for example, Adams 1996; Carswell 2002; Kipkorir 1983; Ssennyonga 1983). It is clearly misleading, however, to claim that local resource exploitation strategies are either unsustainable or environmentally appropriate in the absence of historical data regarding the longevity of practices, or where there is insufficient information concerning changes to the techniques or intensity of cultivation through time. Lack of historical depth and precision thus represents a serious stumbling block to contemporary debates that reference local economic practices, regardless of whether the discussants are proponents or detractors in respect of the value of indigenous knowledge.

For the more recent past, the potential significance of historical information has been highlighted by studies carried out by historians, anthropologists and geographers, and indeed where this work was reviewed above it was described as forming an historical critique that has questioned the assumption that African environments and resource procurement strategies are essentially static, and in doing so has challenged the applicability of more specific models of agricultural change which tend to place undue emphasis on single factors such as population pressure or environmental degradation (see chapter 3, particularly pp. 82-5 and 117-120). Combining this historical information with a more precise understanding of contemporary agricultural systems serves to illustrate further the complexity of this situation, since the dynamism evident in the historical record is matched by the sheer variety of local responses to the problems and opportunities presented by specific environments. As such, attempts to adequately contextualise African agronomies demonstrate that not only have there been innumerable strategies for existing within countless environments, but that the ways in which communities perceive and explain these environments are themselves incalculably varied. This level of spatial and temporal variation demands the production of targeted research aimed at defining how specific communities interact(ed) with their environment, and argues against the simplistic conclusion that the failure of large-scale interventions can be countered by promoting the 'tried and tested' techniques employed by local communities (Adams and Anderson 1988: 532-5), not least because contemporary political, economic, demographic and even climatic changes mean that these communities may be facing unprecedented challenges (see pp. 14-7).

Seen in this light the lesson to be taken from the history of local agricultural adaptations could be simply that agronomies are only ever provisionally stable (Lambert 1985: 114-5; see also Woodhouse, Bernstein and Hulme 2000a: 21 and Behnke, Scoones and Kerven 1993 in reference to savannah management), and that successful strategies rely on the convergence of largely non-replicable historical contingencies. Indeed this is largely the conclusion drawn by McCann (1990: 133) who regards the brief intensification of sorghum (dura) production that took place in the Mazega lowlands of northwest Ethiopia in the early twentieth century as an "historical accident" resulting from a series of events including the recent depopulation of a fertile area; the development of a market in the newly established Italian colony of Eritrea; and the availability of labour drawn from the then declining Red Sea slave trade and from transient *hajj* pilgrims. McCann (ibid.) thus concludes that in terms of development "the Mazega's agricultural revolution is an anti-model since its success derived from a confluence of historical factors [...] rather than a set of synchronic factors which can be replicated". Such a conclusion is mirrored by Anderson's (for example 1988; 1989; 2002) appraisal of the development of the Chamus irrigation system near Lake Baringo, Kenya, between approximately 1840 and 1920 (see p.17 and p. 108) though the re-establishment of small-scale irrigation at Baringo since the 1960s (Adams and Anderson 1988: 530-1; Anderson 2002; Little 1992) demonstrates that these convergences of resources and opportunities can occur at different times for very different reasons.

Yet just as 'historical accidents' can create opportunities, they can also create restrictions which may lead to the 'premature' curtailment of potentially successful economic strategies. As was briefly discussed above (pp. 86-7) in reference to the hypotheses presented by Kjekshus (1977) and Koponen (1988), statements of this sort are open to accusations of 'merrie-Africanism', but individual cases are certainly worthy of investigation and may offer important comparative insights which complement studies of extant agronomies. Amborn (1989: 82, footnote), for example, notes that whilst the terraced landscape in the Konso area of Ethiopia continues to be cultivated intensively, the terraces in the nearby area of Dime are now employed for slash-and-burn agriculture, having been abandoned following conflicts with the Ethiopian empire at the turn of the twentieth century (see p. 131 above). Given that on the basis of current evidence the agronomy at Konso has supported a comparatively high rural population for over five centuries (see pp. 92-4), the possibility that the techniques formerly employed at Dime were equally sustainable deserves to be explored. However, the question remains as to whether Engaruka represents a potential model for development planners as has been suggested for the Kerio valley (Ssennyonga 1983; Adams and Anderson 1988: 533) or whether it should be regarded as an 'anti-model' in the sense used by McCann (1990), as has been implied by Koponen (1988: 383; see p. 147 and 190).

In discussing the possible developmental significance of local agricultural strategies in east Africa, Adams and Anderson (1988: 533) note that "certain indigenous sites (most obviously the Kerio cluster) offer a model that has far outlasted any modern development", thus echoing the conclusions drawn by Adams (1996), Kipkorir (1983) and Watson, Adams and Mutiso (1998), all of whom highlight the poor or counterproductive results of previous attempts to improve or extend the Marakwet and Pokot irrigation systems (see also pp. 138-9 above). If, then, longevity of occupation is to be taken as a criterion of model status, Engaruka would certainly seem to be worthy of consideration. Indeed, given the length of time during which the site was cultivated and the level of landscape modification this occupation produced, it would be hard to view the system as being simply an 'historical accident' analogous to the brief intensification of sorghum production at Mazega. Yet in other respects the 'historical accident' view seems quite reasonable, especially when it is considered that the period of Engaruka's occupation coincided with the comparatively wet climatic episode known as the 'Little Ice Age' (Westerberg 2002 citing Verschuren, Laird and Cumming 2000). In fact, regardless of the as yet undetermined effects this climatic phase had on the site, the success of the economy at Engaruka clearly relied on conditions that are no longer in place, as is evidenced by the existence of furrow off-takes located by now permanently dry stream beds (Sutton 2000 [1998]: 11; 1999: 81-2; 2004: 120-2), and by the excavation results of the current project which demonstrate that prior to the construction of formal irrigation features, the cultivation areas were crossed by a series of natural watercourses. These changes to the hydrological conditions in the area mean that it is difficult to see how a knowledge of previous management strategies could be used to directly inform the practices of contemporary land-holders.

Indeed, it should perhaps be reiterated that Engaruka may never have been a wholly abandoned landscape, since the area was occupied by Maasai communities during the nineteenth century (Sutton 1978: 42) whilst the modern village of Engaruka Juu was established in the 1890s (ibid.; Bertelsen 1995; Sutton 2000 [1998]: 4). Some of the modern farms in this area thus occupy parts of the precolonial field system, most obviously adjacent to the Engaruka but also on land irrigable from the Olemelepo (see figures 5.37 and 5.48) and Makuyuni. Cultivation of this land remains reliant on irrigation features, some of which are almost certainly re-used precolonial stone-revetted furrows (see figure 5.49) whilst others, including the modern furrow linking the Engaruka and Olemelepo, closely mirror the courses of their earlier counterparts. There are thus only very limited areas in which any kind of extension programme could be undertaken and, given that there have been incidents of disputes between farmers at Engaruka and pastoralists who rely on the river further downstream (Sutton 1978: 58, footnote), it would appear that the potential of the Engaruka, Olemelepo and Makuyuni rivers for simple furrow irrigation is already close to being fulfilled.

Similarly, particularly in regard to the development and cultivation of the North and South Fields, the solution adopted by the Late Iron Age community of Engaruka is too tailored to the unique conditions that prevailed at the time of construction to be readily exportable to an alternative location. Such a conclusion thus echoes that made by Adams and Anderson (1988: 533) who, commenting on African indigenous irrigation more generally, note that "it would be impossible to replicate the physical structures of such schemes over large areas; they are too frequently geologically and ecologically particularistic, and there are relatively few sites which offer the potential for irrigation". The brief gazetteer presented in chapter 3 would certainly not contradict this assessment, though it is perhaps worth qualifying Adams and Anderson's comment on site availability by emphasising an issue that they themselves raise elsewhere, that many of the areas with irrigable potential have a history of some level of local exploitation (for example, Adams 1989; Anderson 1989; Fleuret 1985; Hogg 1988). Thus local approaches to resource use, or culturally-defined preferences towards particular economic strategies, further complicate any attempt to export technical solutions between different communities in Africa (Adams and Anderson 1988: 534; Hogg 1988).

However, in discussing the features of Marakwet agriculture that are potentially replicable and paradigmatic, Ssennyonga (1983: 96) focuses not on the technical aspects of furrow construction or crop production, but highlights instead general aspects of the system's management. Specifically, attention is drawn to what Ssennyonga refers to as the agronomy's "institutional integration within the social system [...] its non-bureaucratic management [...and...] its maintenance by the community" (see also Moore 1983: 132). Ssennyonga's recommendations thus correspond closely with those endorsed by proponents of 'development from below' (Stöhr and Taylor 1981; Taylor and Mackenzie 1992) and 'indigenous knowledge' (for example Brokensha and Riley 1991; Sillitoe 1998; Warren, Slikkerveer and Titilola 1989) both of which, in very general terms, see the imposition of external regulation or incentives as a major factor in the failure of many development initiatives, and thus favour the use of 'traditional' or local management strategies (see pp. 11, 13-14, 37-8 and 53-4). Whilst there is clearly nothing in the archaeological data from Engaruka to contradict such a conclusion, the discussion of the strengths and weaknesses of archaeological knowledge presented in chapter 2, and the more specific discussions of African agriculture outlined in chapters 3 (particularly pp. 76-87) and 4, serve to illustrate the limitations of a purely archaeological case-study in this regard. In short, since archaeological reconstructions of resource-use strategies rely on historical and/or ethnographic analogies to provide details of pertinent social structures, if these same social factors are seen as providing the most significant developmental lessons, then archaeological interpretations have little to add since both they and the developmental paradigms depend on the same observation-based sources of evidence (see pp. 71-2). An attempt to re-apply the techniques formerly employed at Engaruka would thus not represent the re-use of 'ancient indigenous knowledge' but would be instead the application of an archaeological interpretation, or the application of selected aspects drawn from such an interpretation. Details of essential but archaeologically invisible management structures such as crop rotations and water rationing would thus have to be drawn from other sources.

Although not couched in precisely these terms, discussions of previous attempts to employ archaeology as a means of defining potentially replicable modes of resource exploitation recognise that the resultant models are an amalgam of historical and contemporary sources of data. Erikson's (for example 1998 [1992] – see p. 34 above) description of the early stages of his raised field rehabilitation project in Peru serves to aptly illustrate this point, since the first attempts to reconstruct and cultivate these abandoned features were undertaken as an exercise in experimental archaeology designed to provide precisely the sort of social detail that could not be discerned through the archaeological data alone. Outlining the methodology and results of an attempt to re-employ Inca terraces and irrigation structures in

Andean Peru, Kendall (2005: 211) draws similar conclusions, arguing that "the information gained in the present [...] also became a feedback to help in the interpretation of the archaeological data". Indeed, the central importance of archaeologically invisible social structures became apparent during this project because an Irrigation Committee formed in 1983 initially struggled to enforce attendance to communal maintenance days (Kendall 2005: 215); an issue that would seem to add support to the conclusion that the relatively recent abandonment of some areas of irrigated terracing in this region was exacerbated by the collapse of the local system of water 'judges', and by the cessation of festivals that were integral to the organisation of communal workgroups (ibid.: 210 and 217 – see also Bebbington 1997).

Rather than add social detail to the study of indigenous management systems, there is therefore a danger that the apparent sustainability of small-scale, 'non-bureaucratic' management structures will take on the status of a new 'received wisdom' and thus simply replace earlier generalised models within archaeological interpretations. However, whilst writers in related disciplines have warned against what they see as a potentially nostalgic paradigm shift whereby the former denigration of local management strategies is simply replaced by a working assumption that indigenous practices are both sustainable and efficient (for example Adams and Anderson 1988: 521-2; Richards 1993: 61), it would seem unlikely that archaeologists would become mired in such a trap for very long, if only because issues of evidential preservation mean that abandoned sites will always be attractive, and such sites will always invite questions of systemic sustainability. In line with the view expressed by Barker and Gilbertson (2000: 4 – see pp. 192), it is at this level that the results obtained by the current project can make a modest contribution to the study of indigenous African intensive agriculture, both by ruling out some of the conjectured causes of Engaruka's abandonment, and by broadly defining the chronological development of the techniques of cultivation.

Thus, at their simplest, the results of the fieldwork reported upon here demonstrate the potential utility of archaeological examinations of abandoned agricultural systems and, in particular, illustrate the importance of achieving an understanding of how local resource-use strategies develop and change through time. Indeed, even relatively minor amendments to the sequence of site development can quite profoundly alter the interpretation of an agronomy and therefore how it is perceived as an example of indigenous agriculture more generally. Thus, in the current example, the recognition that the stone circles are comparatively early features within the sequence of site development does not support the view that these structures are evidence of a relatively late attempt to bolster falling soil fertility by collecting manure from stall-fed cattle (Sutton 1984 and 1986; see pp. 239-42 and 248 above). Similarly, although the soil sample results suggest some degree of nutrient depletion within the field areas (see p. 256), this is not of a level that would indicate catastrophic collapse, and there is therefore no reason to believe that the economy was rendered untenable by a community blindly overworking the site's resource base, or that the farmers at Engaruka were unaware of the effects their actions would have on the area's potential productivity. Moreover, by broadly defining the sequence of terrace and furrow construction it is clear that the extensive agricultural landscape developed gradually, and it would appear that the network of irrigation furrows within the North and South Fields were part of the original field design rather than a later addition designed to intensify production or maintain yields (see pp. 207-213). Nevertheless, the recognition that these areas are composed on low terraces rather than simple, single-coursed field divisions would support the view that the construction and maintenance of the cultivation area was comparatively labour intensive when compared with shifting or recurrent forms of arable production. Since there is no reason to assume that incremental expansion of this kind would require complex social hierarchies capable of commanding a large workforce, it would seem that the decision to repeat the process of field construction was made collectively at a group or sub-group level, and thus must have been undertaken with the expectation that this 'investment' would produce reasonable returns.

Although arguably self-evidently true, the fieldwork results thus serve to emphasise that the Late Iron Age agronomy at Engaruka was very much a dynamic system. However, this is not to say that the system was fundamentally different from superficially less complex African agronomies. Indeed, in common with more recent and better documented examples of African intensive agriculture, the community that established the first of the hillside settlements in the early fifteenth or late fourteenth century did so in order to exploit a range of naturally available resources that were capable of supporting a variety of subsistence strategies, and only later began the process of modifying their environment in order to increase or maintain its potential for arable production. These modifications would eventually lead to the construction of nearly 2000ha of fields and terraces served by a complex network of irrigation features, yet this process of adaptation began with the simple clearance of stones from cultivation areas, and with the re-direction of water from the rivers and streams. As extensive and impressive as the remains of this agronomy now appear, all the features on the site result from the simple desire to manage the available resources: if land was to be cultivated it was necessary to clear the stones from the topsoil, and to ensure that crops receive an adequate supply of water and nutrients; if settlements were to be constructed on the steep hillsides it was necessary to create level platforms on which to build and cultivate; if sloping land was to be cultivated and irrigated it was prudent that this be terraced to conserve soil and water and to avoid nutrient leeching; and if the land adjacent to the numerous streams within the North and South Fields was to be cultivated it was necessary to find a method of controlling the water and entrained sediments that flowed within them. With a period of occupation totalling approximately three to three and a half centuries, these techniques must be regarded as having achieved a degree of success.

By examining the stratigraphy and soil chemistry of the cultivation areas for the first time, the current project thus complements earlier and on-going excavations at the site which have concentrated on the habitation areas, and adds temporal and descriptive detail to the surveys of the field and irrigation systems undertaken by Sutton. Moreover, the results indicate that the relatively simple investigative techniques employed by the current project at Engaruka offer a means to map changes within agricultural systems, and can both examine the consequences of the chosen methods of cultivation and place these consequences within their historical context. Yet despite the fact that the majority of field investigations undertaken at Engaruka have included among their stated aims an assessment of why the area was abandoned, the cause – or as is more likely, causes – of this desertion remain uncertain. Thus, whilst on the basis of current evidence it would seem unwarranted or at least premature to regard the agronomy as inherently unsustainable, that the question of abandonment remains unresolved serves as a reminder that archaeological enquiries cannot provide simple answers to complex questions. If archaeologists are to make a contribution to debates regarding the efficacy of indigenous agriculture therefore, it is necessary to offer a realistic assessment of the discipline's strengths and weaknesses in this regard (see for example Kinahan 2000: 247). Presenting future application as somehow an inevitable consequence of archaeological research into agricultural systems should thus be viewed as extremely misleading (see, for example, the comments made by Minnis [2000: 271] cited on p. 30 above). As such, it is also necessary to correct the false impression received by some writers outside the discipline that the apparent objectivity of stratigraphic or palaeoenvironmental research produces results that are unambiguous and hence readily applicable (for example Niemeijer 1996: 94 and 103-6 – see p. 146 above). Indeed, recognising that research of this kind has a relevance and audience outside the discipline should also caution against the use of historically ambiguous terms such as 'ancient' or 'traditional', or the use of chronologically imprecise, often rhetorical, phrases such as referring to the size, population or cropping capabilities of a site 'at its height'.

Thinking in terms of an applied archaeology thus forces practitioners to make explicitly clear where interpretations are drawn from archaeological material and where they are inferred from other sources, the latter of which of course includes the archaeologist's own experiences and presuppositions. Indeed, without this explicit exposition of sources and inferences there is a danger that archaeological interpretations will be employed in misleading and circular arguments, whereby ethnographic analogies and economic models are used to produce archaeological case studies which are then cited within the ethnographic, economic and developmental literature as evidence of the continuity of local practices (Stahl 2001: 25). Stahl refers to the histories thus produced as 'ethnographic pasts' (2001: 22 following Chance 1996) and notes that these risk reinforcing the stereotype that African communities are static. Yet in the context of the current discussion there is an additional danger that these circular arguments will give the false impression that indigenous resource-use strategies are long-lived and hence both environmentally and economically sustainable. Viewed from this perspective the citation of archaeological case studies by the proponents of various economic models or arguments (for example Boserup 1981 – see p. 129) means that archaeology is already involved in these discourses at a narrative level; a situation that has a contemporary relevance beyond the current issue of developmental debates since subtly different forms of neo-Malthusianism are also frequently invoked by environmentalists and by proponents of the genetic modification of crops (Stone 2005). The ability to question the veracity of these models in respect of specific communities thus represents an important contribution to developmental discourse in its own right, but such a contribution necessitates a realistic assessment of the different degrees of resolution offered by various disciplines or methodologies, and in many cases may simply oblige archaeologists to state explicitly that the available evidence is ambiguous in respect of these issues.

In Collingwood's (1940, 1946 and 1999) terms, then, an applied archaeology requires an openness about the process of re-enactment and about the constructive inferences therein (see chapter 2, particularly pp. 42-48, 52, 59, 60, 70). In terms of the direct application of archaeological data, such an approach changes the relationship expressed by Collingwood's (for example 1999: 152) distinction between 'what probably happened' and 'what may have happened', because any project that sought to re-apply or export archaeologically defined aspects of indigenous technical knowledge would be likely to prioritise functionality over historical accuracy. In other words, since the aim is clearly not the creation of 'living museums', archaeologically defined modes of resource exploitation or landscape use are likely to be combined with social structures, management strategies, technologies or crop species which may not have been employed in an earlier period. Consequently, as was discussed in the concluding section to chapter 2, such an approach also changes the relationship between archaeology and the communities that form its 'ethnographic parallels', since rather than treat these as perceivable substitutes for the lost thoughts or actions of past societies, they are treated instead as knowledgeable actors and their opinions actively sought as to how former areas of cultivation may have been managed in the past, and how they may be utilised in the present. Thus an applied archaeology offers an intellectually honest response to the interrelated issues of cultural relativism and epistemological incommensurability which recognises that these issues are inherent within the process of historical re-enactment, but which does not require the logical inconsistencies of 'partial objectivity' (Hodder 1992: 191) or 'negotiated pasts' (Schmidt 1995: 120). Moreover, it suggests the possibility that utility, rather than the subjective and hence problematic criteria of 'importance', could be employed as a principle of archaeological site selection, given that the relativist response of blanket protection for all so-called 'heritage resources' is an unaffordable ideal within the developing world.

Summarising Collingwood's philosophy of history, Hirst (1985: 45) considers that Collingwood pragmatically sought "a conception of truth which indeed could not be outside its time, but which would be as right as it was possible to be *in* its time; which was not true because separated from presuppositions, questions and value positions but true *because* of them" (emphasis in original). An applied archaeology of agricultural systems is entirely consistent with such an aim, and is an approach that has the potential to fully address Childe's (1956: 127) ambition that "archaeological knowledge may someday prove useful to some society". Yet as theoretically desirable as such an approach may be, the examination of the specific and general case-studies presented above suggests that the feasibility of this line of enquiry may be limited, perhaps ironically, by the level of dynamism that is so often assumed to be absent within African agricultural communities. Large areas of formerly productive, abandoned agricultural structures like those investigated by archaeological projects in South America and the Negev are largely absent within Africa, where communities have either adapted to changing conditions through successive periods of intensification and disintensification, or where areas vacated by one intensive agricultural community have been subsequently re-occupied by another (for example Sonjo occupation of what may once have been Engaruka Complex sites, and the use of irrigation structures by Maasai communities in what were probably former Sonjo areas of irrigated cultivation at Pagasi – see pp. 97-8 and 100-101). Nevertheless, the presence of abandoned settlements and/or agricultural areas at Konso (Kimura 2004), Kilimanjaro (Sutton 1991: 29 citing Kimambo 1968; Tagseth pers. comm.), Marakwet and Pokot (Watson pers. comm.), Pare (Sheridan 2002: 86), Sonjo (Gray 1963: 11; Adams, Potkanski and Sutton 1994: 22-3), and on several of the islands of Victoria Nyanza (Conelly 1994; Posnansky, Reid and Ashley 2005) mean that the opportunity to add an archaeological component to the study of east African 'intensive' agriculture also exists at many of the other areas discussed above.

Moreover, with relatively high population densities based in long-lived settlements supported by permanent or semi-permanent water and soil conservation features, the areas that are most attractive to advocates of indigenous knowledge-based extension schemes (for example Reij, Scoones and Toulmin 1996) are also those which are the most visible archaeologically. It is very likely, therefore, that these areas would be susceptible to the techniques employed by the current project at Engaruka, with the additional advantage that the close spatial and possible cultural relationships between these extant and abandoned agricultural structures present opportunities to employ archaeological techniques alongside interview and observation based methods of research. Since the current vogue for the use of 'indigenous knowledge' in development planning shows no sign of abating in the immediate future, this combination of contemporary and historical approaches should produce a more complete understanding of the long-term history of specific examples of African intensive agriculture, and in doing so would provide information essential to adequately qualify these debates.

Archiving

The material archive from the 2002 and 2003 excavations comprises samples of pottery and faunal remains. This does not require conservation and is currently held in the stores of the BIEA, Nairobi. The paper archive comprises record sheets, photographs, scaled drawings and digital survey data, all of which are currently held by the author. Arrangements will be made to deposit both the material and paper archives with The United Republic of Tanzania Ministry of Natural Resources and Tourism Antiquities Unit, Dar es Salaam. A digital copy of this thesis and a summary of the paper archive in pdf. format will also be deposited with the Antiquities Unit and with the Tanzanian Commission for Science and Technology (COSTECH), Dar es Salaam.

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